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Essays in Aggregate Information, the Media and Special Interests

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by

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To Angeliki.

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ABSTRACT OF THE DISSERTATION

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The influence of special interests and the important role of the media in modern democracies are undeniable. In this dissertation, we employ different tools, namely game theory, experiments and models of political economy, to delve into this important problem. In the first chapter, we approach this issue from a game-theory perspective. In an anonymous dynamic setting we add the assumption that there is a "planner", who knows and selectively reveals aggregate information to maximize his objective function.

We find that this approach yields a useful refinement of self-confirming equilibrium. We also show that in some cases partial information revelation is optimal. Finally, our model indicates that affirmative action may be desirable, demonstrating the value of generating information about special social groups. In the second chapter we examine the effects of the release of aggregate information experimentally. We perform a series of experimental sessions of a version of the "centipede game" with aggregate information release. With a payoff structure similar to previous experiments, we find that revealing public information causes strong convergence to Nash equilibrium and leads to significantly lower aggregate payoffs. However, after slightly changing the payoff structure of the game, the effects of public information shift dramatically in the opposite direction. Theories that assume that people exhibit "conditional moral motivation" are supported by our results. In the third chapter, we focus on the political economy aspect of the media and special interests. If the investment decisions of private firms determine economic growth and employment, voters have a common interest in making their governments commit to policies that encourage private investments. However, governing parties may, in general, renege on promises for economic stability. Campaign contributions by firm interests tend to restraint the scope of this opportunism and provide a commitment device. This is achieved if the private sector in the political game gets to move after the policy is chosen, contributing to the governing party or to its rivals. Anticipating this, the governing party will choose not to follow opportunistic policies and firms will choose a high level of investment and society as a whole may benefit.

Chapter 1. Selective Revelation of Aggregate Information and Self-Confirming Equilibrium

1. 1 Introduction

Social interactions among strangers can be modeled as games of large populations with anonymous matching.[1] The choices of a specific player who is matched against an opponent are based on the player's expectations concerning the "average" behavior of the opponent's population. However, people rarely have enough interactions with members of other populations in order to form accurate expectations about the behavior of all other social groups. The notion of self-confirming equilibrium (SCE) of Fudenberg-Levine (FL) (1993*a*) describes a state where people optimize given their beliefs about other groups, but individual beliefs need not be correct about groups they do not interact with.[2] Further, members of the same population may have different experience and hence different beliefs. The fact that some members of a given population interact with a social group does not necessarily mean that the other members of the population share their knowledge and have correct beliefs about the behavior of this group.

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[1] There is a large debate concerning the degree of sophistication of agents, since evolutionary models consider players "naïve learners". See Mailath (1998), who offers support for this hypothesis of evolutionary theories against its criticisms. We believe that relatively weak assumptions about the sophistication of players are enough to justify our results. We shall further discuss the degree to which assumptions of naiveté need to be invoked in our model.

[2] For example, people of one ethnic group may be brought up having strong prior beliefs that the members of another ethnic group hate them. Consequently, they avoid interacting with that group. If this belief is wrong, it cannot be falsified, and hence is never corrected.

However, governments and special interests often have asymmetric access to aggregate data about the behavior of social groups. By revealing their special information they may correct the beliefs of the public regarding the behavior of others, and possibly change people's actions. Therefore, selective information revelation of aggregate data can become a powerful policy tool that the possessors of information can use to achieve their goals. This is especially relevant in modern societies, where agents directly learn information about the aggregate data through the media. This information need not necessarily be exogenous, because the availability of aggregate data depends on the incentives of those who have them to disclose them. In some sense, these possessors of information can choose what "wrong beliefs" can survive in the long-run. Accordingly, a given self-confirming equilibrium is plausible as the long-run state of the economy only if the possessors of aggregate information cannot choose a more preferred equilibrium for them, in the sense we shall define bellow.

For a specific example, we ask the reader to look at Figure1.1. Assume that there are two social groups, investors and officials (player1's and 2's, respectively). The investors move first, deciding whether to invest (denoted by E) or not, and then officials choose whether to cooperate or not.[3] The investment is profitable only if the official cooperates. The numbers in the brackets show the fractions of the social groups making each action in the specific "state" of the dynamic system we are considering. One fifth of the investors have taken the risk of investing before, and they have leaned the truth: that the officials are upright, and they always cooperate (C) without asking for a bribe.

[3] When officials do not cooperate, they illegally try to expropriate rents from the investor.

However, 80% of investors choose to refrain from investing, holding strong prior beliefs that the officials are corrupt. This state of affairs, being a SCE, is stable in the sense of FL, 1992*a* .

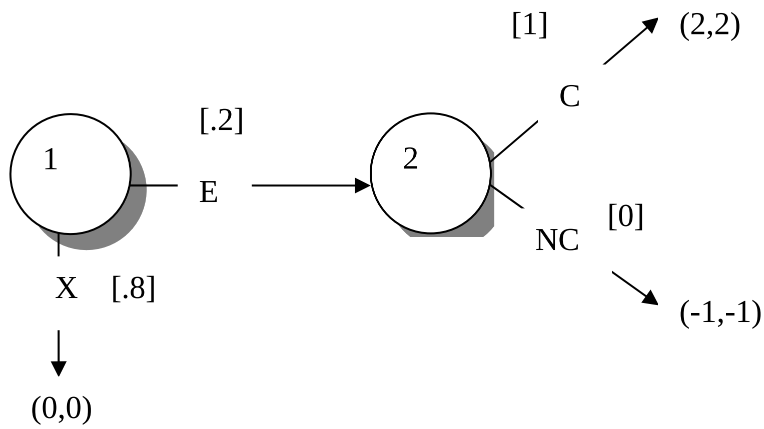

Figure 1.1
The Modified Cooperation Game

We claim that this equilibrium is implausible. Although 80% of investors are better off not investing given their priors, they would change their behavior if they knew the true behavior of officials. However, if the government possesses the data that reveal this behavior and wishes to maximize social surplus, it ought to reveal this information. Knowing the true data about corruption, it may announce the true behavior of officials through the media. Accordingly, the behavior of investors may change by observing the true data. Clearly, revealing the fact that officials are honest will induce investors to enter, upsetting the equilibrium. The new profile where all investors enter and all officials behave honestly is also a steady state because it is a self-confirming equilibrium. Moreover, the government prefers this steady state than the previous one, so it has the incentive to reveal this information.

The basic theoretical tool we employ is the notion of self-confirming equilibrium[4]. The key idea is that if people do not experiment enough, aggregate play need not result in Nash equilibrium outcomes.[5] In our theoretical model, we simply add the existence of a "planner", who knows and selectively reveals aggregate information to maximize his objective function, to the general framework of FL. Individuals do not know anything more about the behavior of other social groups than what personal experience teaches them, unless the planner reveals information, which is always perceived to be true. Our results have theoretical significance, but they are also important for policy proposals and for understanding several important social phenomena. Our key insight is that, deciding whether a particular self-confirming equilibrium with non-Nash outcomes is a plausible rest point for the dynamic social interaction, one should look at the incentives of those who have aggregate information.[6] This is because selective information release by the planner may upset a given self confirming equilibrium and lead the system into a different one. Moreover, we show that aggregate information

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[4] See Fudenberg and Levine (1993*a*), Hahn (1997) and Kalai and Lehrer (1993).

[5] The main question that can be asked about SCE is: why would agents fail to experiment to learn the true behavior of others? One way to understand this is to acknowledge the fact that many decisions in life do not permit experimentation. For example, if some action of one social group results in the death of agents belonging to another group, these agents are not very likely to experiment with the social interaction. Alternatively, in many real decisions each player can move only once and for all. For example, a person decides only once whether to attend law school. Experimentation is not possible here without a high cost, and priors play a major role here. Of course, each player can be viewed as a part of a population who share some characteristics, like in Jackson and Kalai's (1997) "recurring" games. Thus, one can learn from the previous experience of others, and this is exactly where selective information revelation can have a major role. Alternatively, a non-Nash SCE can be reached if there is a very large number of possible actions and a finite life span. For example, no customer has a comprehensive knowledge of which products in a given supermarket satisfy her preferences best, because nobody can try them all. This is a reason that selective information revelation is widely used by advertisers.

[6] We take the knowledge of aggregate statistics by the planner as given. Our setting can easily take into account the cost of aggregate information acquisition as well as multiple "planners" with possibly conflicting interests.

release can sometimes be beneficial for society, but not always. In particular, we show that "self-censorship" can be optimal in a wide range of games. Furthermore, information revelation requires "socially beneficial" data, so we show that information-generating "affirmative action" may be useful. Finally, our framework has a wide variety of applications in Industrial Organization, Political Economy, Public Policy and other fields.

In the paper which is closer to our spirit, Esponda (2006) has a theoretical model that focuses on a specific type of games, namely first price auctions. He asks whether the equilibrium feedback policy, which in most cases may be decided by the auctioneer, may affect equilibrium outcomes. He thus provides a very specific example of a "planner" and shows how he selectively reveals information about the aggregate data to maximize his objective function. Here we generalize this approach to abstract extensive-form games. The literature on herding behavior and information cascades also raises the issue of aggregate information management. Bikhchandani, Hirshleifer and Welch (1992), argue that fads that are due to information cascades are sensitive to aggregate information revelation because the agents use very few of the available signals. Jackson and Kalai (1997) examine "recurring" games in which each player plays only once, but the same game is repeated with different players every time. Information revelation of aggregate play has substantial effects here, because each player learns something about herself when she gets information about the history of her group. Their conclusions regarding the benefits of "affirmative action" are similar to ours.

The experimental literature has also addressed the issue of whether revealing aggregate information matters and whether expectations of agents can be manipulated. Roth and Schoumaker (1983) and Harrison and McGabe (1996) directly manipulated subjects' expectations about others' play in an ultimatum game, with significant and lasting effects. Berg, Dickhaut and McCabe (1995) and Ortmann, Fitzgerald and Boeing (2000) performed experiments of one-round trust games,[7] and found some support for the notion that information revelation of aggregate data can push the economy to desirable equilibria.[8] Similar results were found in Maniadis (2007), Frey and Meier's field experiment (2003), Dufwenberg and Gneezy (2002) and Hargreaves–Heap and Varoufakis (2002).

The remainder of the chapter is organized as follows. In part two we introduce the model, following Fudenberg-Levine (1993*a*) and define Nash and self-confirming equilibrium. In part three we introduce the planner, define the notion of revelation unstable self-confirming equilibria and provide examples illustrating the definitions. A brief discussion of the plausibility of our assumptions follows in part four. In part five we discuss when equilibria cannot be improved upon with information revelation. Part six examines conditions under which concealing information (which we call self-censorship) makes sense. Part seven discusses Partial-Revelation Improvable Self-Confirming

[7] Each "sender" had 10$ that he could send to the receiver. The amount sent tripled, and then the receiver decided how much money to send back to the sender.

[8] They played the game once with some students, and subsequently they showed the data about the actions chosen to different students that were about to play the game on a different date. They found that information revelation about the same game played by different subjects does affect behavior in ways that increase social surplus.

Equilibria. Examples and applications of our approach are in part eight. Part nine concludes.

1.2 The Model

In our model, we endogenize the information players get as play evolves. Our point of departure is Fudenberg and Levine's approach (1993*a*,1996) in assuming that players see only the result of play in their own matches.[9] The framework of Fudenberg-Levine (1993*a*) is a dynamic setting with anonymous matching of agents that belong to different "population-roles". Taking as given the main results of this research, especially the possibility of the game settling in a self-confirming equilibrium with non-Nash outcomes, we shall examine how a planner can convey the aggregate information he has, in the best possible way, in order to change the equilibrium outcome. We shall show that some self-confirming equilibria are not plausible in the presence of the planner, because by selectively - but truthfully - revealing aggregate data, the planner can move the system to a different equilibrium outcome, preferable for him. In the presence of the planner, only some forms of wrong beliefs survive in the long run.

1.2.1 The Extensive-Form Dynamic Game

There is a given extensive-form game with I players. By I we denote the set of all players. The game is played repeatedly among anonymous agents randomly matched with each other. They know the extensive form of the game, the realized terminal nodes of

[9] An underlying assumption we use is that a fictitious play process describes the evolution of learning.

their games after each match, and their payoffs at all terminal nodes, but not necessarily the payoffs of other players.

The extensive-form game is as follows. There is a game tree X with finitely many nodes $x \in X$. Nature's move, if there is one, is at node zero. The terminal nodes of the tree are $z \in Z \subset X$. Information sets, which are a partition of $X - (Z \cup \{0\})$, are denoted by $h \in H$, and the subset of information sets where player i has the move, by $H_i \subset H$ .We denote the set of feasible actions for player i at information set h_i by $A(h_i)$, and all possible actions of player i by $A_i = \bigcup_{h_i \in H_i} A(h_i)$. We denote the player who moves at node x by $\iota(x)$. The function ℓ assigns for each noninitial node x the last action taken to reach it.

A pure strategy for player i is a map $s_i : H_i \to A_i$ satisfying $s_i(h_i) \in A(h_i)$ for all $h_i \in H_i$. Let $S_i = \times_{h_i \in H_i} A(h_i)$ be the set of all such strategies. Strategy profiles specify a pure strategy for all players, and we denote such a profile by $s \in \times_{i=1}^{I} S_i$. A mixed strategy for player i is a probability distribution over pure strategies, $\sigma_i \in \Delta(S_i)$, and a profile of mixed strategies is denoted by $\sigma \in \times_{i=1}^{I} \Delta(S_i)$. The payoff for each player depends on the terminal node. So for players $i = 1,2,\cdots,I$ the payoff function is $u_i : Z \to \Re$.

Let $H(s_i)$ [$Z(s_i)$] denote the subset of all information sets [terminal nodes] reachable when agent i plays s_i. $\bar{H}(\sigma)$ denotes the set of information sets that are reached with positive probability under σ, and $\bar{Z}(\sigma)$ denotes the set of all terminal nodes that are reached with positive probability under σ. A behavior strategy π_i for player i is a map from the set H_i, the family of all information sets where this player has the move, to probability distributions over moves. That is, $\pi_i(h_i) \in \Delta(A(h_i))$. Denote the set of all such strategies for player i with Π_i and denote by $\pi \in \times_{i=1}^{I} \Pi_i$ a profile of behavior strategies. Let also Π_{-i} be the space of behavior strategies for the players other than i. We assume perfect recall, so by Kuhn's theorem, every mixed profile induces an equivalent profile of behavior strategies. Let $\pi(\hat{h}_j / \sigma_j)$ denote the distribution of actions at information set h_j induced by mixed strategy σ_j for player j. Let also $p(x/\pi)$ be the probability that node x is reached under the profile of behavior strategies π.

Absent information revelation by the planner, players do not know the true distribution of play, so there is strategic uncertainty. Each player has beliefs over the aggregate distribution of play. These beliefs are described by a probability measure μ_i on Π_{-i}, the set of profiles of behavior strategies of other players. Given player i's beliefs μ_i about other players' behavior strategies, the probability that terminal node z is reached when player i chooses pure strategy s_i is $p(z/\mu_i, s_i) = \int_{\Pi_{-i}} p(z/\pi_{-i}, s_i)\mu(d\pi_{-i})$

Accordingly, the expected utility of an agent with beliefs μ_i when she plays strategy s_i is

$$u_i(s_i, \mu_i) = \sum_{z \in Z(s_i)} u_i(z) p(z/s_i, \mu_i)$$

In this environment, Nash equilibrium can be defined it terms of players' beliefs for opponents' behavior strategies. A Nash Equilibrium is a profile of mixed strategies σ such that for all i, and for all $s_i \in \text{support}(\sigma_i)$, there exists beliefs μ_{s_i} such that:

a) s_i maximizes $u_i(\cdot, \mu_{s_i})$

b) $\mu_{s_i}[\pi_{-i} \in \Pi_{-i} : \pi_j(h_j) = \hat{\pi}_j(h_j / \sigma_j)] = 1$ for all $h_j \in H_{-i}$

Thus, a Nash equilibrium is the profile consisting of the best responses of agents to their beliefs about the aggregate distribution of play, where these beliefs are correct for every information set of the game. However, if players do not experiment enough, they may never get to know true play in all information nodes. They may end up in a situation where as far as they can tell, their actions are optimal, but without a necessarily correct assessment of play in information nodes that they do not reach given their strategies.

This is captured by the following equilibrium notion: a self-confirming equilibrium is a mixed strategy profile σ such that for all i and all $s_i \in \text{support}(\sigma_i)$ there exists beliefs μ_{s_i} such that:

a) s_i maximizes $u_i(\cdot, \mu_{s_i})$

b) $\mu_{s_i}[\pi_{-i} \in \Pi_{-i} : \pi_j(h_j) = \hat{\pi}_j(h_j / \sigma_j)] = 1$, for all $j \neq i$ and $h_j \in \bar{H}(s_i, \sigma_{-i})$

This means that in a self-confirming equilibrium, a specific individual i must hold correct beliefs about the behavior of opponent groups only at nodes that are reached with positive probability given i's strategy and the mixed profile of i's opponents. Thus, an individual that belongs to population i may have wrong beliefs about the distribution of opponents' play at information sets reached with positive probability by other players who belong to the same population i and choose a different strategy than the specific individual. In a SCE, only agents with the same "experience" in equilibrium are required to have the same beliefs.

1.3 Revelation-Unstable Self-Confirming Equilibria

We shall show that selective information revelation can "direct" the economy away from specific self-confirming equilibria. In this section we assume that there is a "planner" who maximizes his payoffs $U^{PL}(\sigma)$ that depend on the long run "state" σ. The planner, who at any given time knows the true distribution of actions at each information set, can announce it at a subset of information sets.[10] His announcements are true and are always perceived as such.[11] Note that the planner has generic payoffs. For example, the auctioneer, who chooses the level of information feedback in an auction, wishes to maximize his revenue; a "benevolent government" maximizes social welfare, etc. In our motivating examples $1, 2$ and for our main results we will focus on the "benevolent government" interpretation. The main idea here is that if the planner can achieve a better social result than a given self-confirming equilibrium with aggregate information revelation, then this equilibrium is implausible.

[10] This subset has to satisfy some properties we shall explain bellow.

[11] This can be though as a benchmark case for analysis. Our key insights would not change if we assume that a given fraction α of each subgroup believes the planner's announcements, and another fraction $1-\alpha$ ignores the announcements. Clearly, the quantitative results depend on the parameter α, but the qualitative ones carry over if we assume that only some people believe the planner, so that α is not zero. This assumption is more convincing in some real economies, such as advanced democracies, than others, such as totalitarian regimes. Note that by always selectively revealing true information, the planner can also develop a reputation for truth-telling.

1.3.1 The Full Information Revelation Setting

We shall assume that for the equilibria we are discussing in this setting, $\bar{H}(\sigma) = H$. For full information revelation, information about play in all information sets should be available. Intuitively, if the planner wants to reveal the aggregate distribution of play at all information sets, then there must be data available for him to disclose. If, in a specific self-confirming equilibrium, an information set h_j is never reached, there is nothing to be announced about the behavior of player j's at this set. If this condition does not hold, then we can only have partial information revelation.

Definition 1[12]: A self-confirming equilibrium σ is full-revelation unstable relative to planner's preferences, if there exists a mixed profile σ^* such that:

a) For all i and for all $s^*_i \in \text{support}(\sigma^*_i)$, s^*_i maximizes $u_i(\cdot, \mu^*_{s_i})$, where for each i and for all $s^*_i \in \text{support}(\sigma^*_i)$, $\mu^*_{s_i}$ satisfies $\mu^*_{s_i}\{\pi_{-i} \in \Pi_{-i} : \pi_j(h_j) = \hat{\pi}_j(h_j / \sigma_j)\} = 1 \ \forall h_j \in H_{-i}$.

b) σ^* is a Nash Equilibrium profile.

c) $U^{PL}(\sigma^*) > U^{PL}(\sigma)$.

d) $u_i(s^*_i, \mu^*_{s_i}) > u_i(s_i, \mu^*_{s_i})$, for some i, some $s_i \in \text{support}(\sigma_i)$, and some $s^*_i \in \text{support}(\sigma^*_i)$.

---

[12] The notation $\mu^*_{s_i}$ emphasizes the fact that, following information revelation, each pure strategy s_i in the old equilibrium could be associated with different beliefs than different pure strategies of the same population. Note that for this particular definition, this notation does not make a difference, since all agents have the same (correct) beliefs. However, it matters in definition 2 which follows, since the new beliefs associated with each pure strategy s_i of the old equilibrium need not be correct in all nodes.

This definition says that a self-confirming equilibrium is “full-revelation unstable” if an announcement of the true distribution leads to a better equilibrium for the planner. Since the planner’s information revelation is always truthful, agents’ beliefs μ^* after the planner’s full information revelation assign probability 1 to the revealed distribution, induced by σ. The best-responses to these beliefs generate profile σ^*. The key part in this definition is that the best-responses to the old distribution of play are also best-responses for the distribution which occurs after the information revelation takes place, that is, $\forall i, \sigma^*{}_i$ a best response to $\sigma^*{}_{-i}$. Hence, the change in the state of the dynamic system following an information announcement is sustainable. Condition (e) ensures that at least one player has a strict incentive to change her behavior.

Example 1. We shall illustrate definition 1 showing how a self-confirming equilibrium can be undone by information revelation that leads to a better outcome for the planner. Consider the social interaction between investors and officials presented in the introduction (Figure 1.1, page 3). We will analyze more strictly the arguments here. Note that the game is similar to a trust game, but here the subgame perfect equilibrium outcome (E,C) is good for society. If player 1’s believe that player 2’s will cooperate, their best-response is to enter, whereas if they think player 2’s will not cooperate, they should refrain from entering. We assume that there is a benevolent government, the objective of which is to maximize social welfare, which depends on the terminal nodes of the game, and the frequency at which each terminal node is reached. Accordingly,

$U^{PL}(\sigma) = \sum_{z \in Z} \{ p[z / \hat{\pi}(\sigma)] \sum_{i=1}^{I} u_i(z) \}$ is the planner's objective function, as a function of the "state", the mixed strategy profile σ.

Assume that the state of the economy is described by the specific profile of mixed strategies σ, illustrated in Figure1.1, where one-fifth from the population of player 1 's enter, believing that player 2 's cooperate with probability one, and four-fifths exit, believing that 2 's never cooperate. In fact, player 2 's always cooperate. So, the initial self-confirming equilibrium is $\sigma = \{(0.8X, 0.2E); C\}$.[13] Assume that the planner announces the true aggregate distribution of actions in all decision nodes. If player 1's simply best-respond to their beliefs about player 2 's play, and they regard the information revelation as truthful, then they all enter after the announcement since they expect that 2 's will cooperate.

The new state of the game, profile $\sigma^* = \{E; C\}$, is very compelling as a steady state, despite the fact that the players best-respond to the correct beliefs about the *previous* period, which assign probability one to *that* period's distribution of play. The reason is that σ^* is a Nash Equilibrium, so players also best-respond to the current distribution of play as well. The planner prefers σ^* to the old profile because more profitable transactions take place and thus has the incentive to fully reveal the aggregate information. Hence, σ is full-revelation unstable.

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[13] Note that this is just one of infinitely many self-confirming equilibria in this game. Any mixed strategy of population "one"coupled with fraction 1 of population "two" playing C is a self-confirming equilibrium. We chose this specific fraction for illustrative reasons.

1.3.2 Partial Information Revelation

Here we assume that not all information sets need to be reached, so it is possible that $H(\sigma) \neq H$. Moreover, we assume that the planner may announce only partial information. Of course, the planner may only reveal information about behavior at information sets reached with positive probability under σ, otherwise there is nothing to announce. Consequently, the planner may reveal the distribution of play at a subset of the family of all information sets reached with positive probability under σ. Hence, if we denote by H^A any set of information sets, for which the planner reveals the distribution of moves given σ, the following must hold:

$$H^A \subseteq \bar{H}(\sigma) \qquad (1)$$

For simplicity, we also require that the planner may only reveal information for all or none of the information sets of each population:

$$H^A = \bigcup_{j \in J \subset \mathrm{I}} H_j \qquad (2)$$

Definition: A set $H^A(\sigma)$ which satisfies (1) and (2) given a profile σ, is called an "information revelation set on σ".

For concreteness, denote by J_{H^A} the subset of I associated with the specific information revelation set H^A. We want to restrict ourselves to self-confirming equilibria with independent beliefs. A self-confirming equilibrium σ has independent beliefs if for all players i and all $s_i \in \text{support}(\sigma_i)$, the associated beliefs μ_i

satisfy $\mu_i(\times_{j\neq i}\bar{\Pi}_j\} = \times_{j\neq i}\mu_i\{\bar{\Pi}_j\}$ for all measurable $\bar{\Pi}_j \subseteq \Pi_j$ (Fudenberg-Levine1993*a*).[14]

Now, fix a SCE σ supported by beliefs μ. Since the information revelation of the planner is truthful, following the announcement of the planner, the beliefs of all players must be consistent with the distributions he announces.

Definition: We say that an information revelation set H^A on a SCE profile σ**,** supported by beliefs μ, generates "transition beliefs" μ^* if for all i and for all $s^*_i \in$ support (σ^*_i) the beliefs $\mu^*_{s_i}$ satisfy:

$\mu^*_{s_i}\{\pi_{-i} \in \Pi_{-i} : \pi_j(h_j) = \hat{\pi}_j(h_j/\sigma_j)\} = 1$ for all $h_j \in H^A$, and $\mu^*_{s_i}\{\bar{\Pi}_j\} = \mu_{s_i}\{\bar{\Pi}_j\}$ for all $j \notin J_{H^A}$ and for all measurable $\bar{\Pi}_j \subseteq \Pi_j$.

Since agents do not know the payoff functions of others, they do not understand the strategic behavior of the planner, nor do they evaluate changes in others' behavior following the announcement. They simply believe the information announcement and adjust their play accordingly, believing everything else is the same. This idea is captured by "transition beliefs".

[14] Kuhn has shown that these beliefs are equivalent with point-valued beliefs at a unique strategy profile of opponents π^i_{-i}.

Definition: Let σ be a SCE supported by beliefs μ. For a fixed information revelation set H^A on σ, we say that σ^* is a profile supported by H^A if:

For all i and for all $s^*{}_i \in$ support($\sigma^*{}_i$), $s^*{}_i$ maximizes $u_i(.,\mu^*_{s_i})$ where the beliefs $\mu^*_{s_i}$ are the transition beliefs generated by H^A. (3)

In other words, an information revelation set supports a profile σ^* if the transition beliefs it generates support σ^*. Note that a given σ^* may be supported by multiple transition beliefs, but a specific information revelation set H^A generates unique transition beliefs.

Definition 2 : A self-confirming equilibrium σ, supported by beliefs μ, is partial-revelation-unstable relative to the planer's preferences, if there exists an information revelation set H^A on σ, and a mixed profile σ^* such that the following hold:

a) σ^* is a profile supported by H^A.

b) σ^* is a self-confirming equilibrium, which for all i and for all $s^*{}_i \in$ support($\sigma^*{}_i$), is supported by beliefs $\mu_{s_i}{}^*$ for all $h_j \in H_{-i} - \bar{H}(s^*{}_i, \sigma^*{}_{-i})$.

c) $U^{PL}(\sigma^*) > U^{PL}(\sigma)$.

d) $u(s_i^*, \mu^*_{s_i}) > u(s_i, \mu^*_{s_i})$, for some i, for some $s_i \in$ support(σ_i), and for some $s^*{}_i \in$ support($\sigma^*{}_i$).

This means that if all agents simply update their beliefs assigning probability 1 to the planner's announcements, and they keep their old beliefs in the nodes about which there is no revelation, then their best responses to the new beliefs form a self-confirming equilibrium profile. Again, this self-confirming equilibrium is compelling as the new steady state of the system, because if this profile is played, agents update information only in the information sets in $\bar{H}(s^*_i, \sigma^*_{-i})$, hence they want to continue their chosen actions since this profile is a self-confirming equilibrium. In information sets outside $\bar{H}(s^*_i, \sigma^*_{-i})$, agents maintain their old beliefs, and they do not have reason to update them in the absence of active learning.

Example 2. We shall show that with partial information revelation, the planner can achieve more than what he can achieve with full information revelation, even when $\bar{H}(\sigma) = H$. Assume that the planner's preferences are as in example 1. Consider the self-confirming equilibrium presented in Figure 1.2, which is the profile $\sigma = \{(.5P1, .5T1); (.5P2, .5T2); (.2P3, .8T3); P4\}$.

The pure strategies for players are "pass" (the horizontal move) or "take" (the vertical move). Half of player 1's and half of player 2's do not pass, although it would clearly be optimal for them to do so given behavior of player 3's. The beliefs supporting this self-confirming equilibrium are as follows. Player 3's who "take" believe that player 4's "take" with probability $\alpha > \frac{1}{2}$ and player 2's who take believe that player 3's "pass" with probability 1. Finally, player 1's who take believe that player 2's "take" with probability $\frac{3}{4}$ and player threes pass with probability 1. Of course, all players have correct beliefs about all the other nodes.

The best outcome for society is $(4,4,0,1)$. There are many possible announcements that may increase the frequency of this outcome. If the planner announces the aggregate play of player threes, she can induce player 1's and 2's to enter. However, if she were to announce also the play of player 4's, all player 3's would pass, and the outcome would be $(0,0,2,1)$ which is clearly worse for the planner.[15] In this example, full information revelation would not work, because some players have a "superstition" (wrong beliefs) that is beneficial for society and should be maintained. Player 3's who play "take" have this "beneficial superstition".

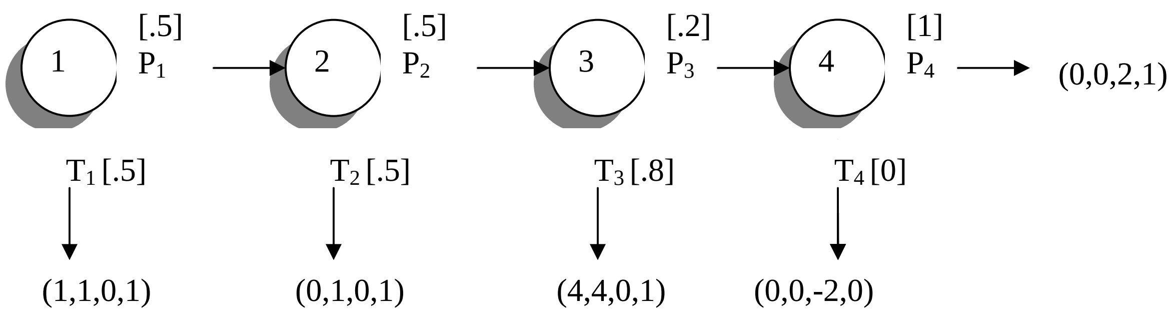

Figure 1.2
The Beneficial Superstition Game

[15] Notice that if player 1's realized that aggregate play is common knowledge, and in addition could think strategically given the others' payoffs, they would not pass. However, here we assume that players do not know the payoffs of their opponents.

Assume that the planner announces aggregate behavior at node 3. Players' best responses to the new beliefs leads to $\sigma^* = \{P1, P2, (.2P3, .8T3), P4\}$. Note that this profile describes the best response of all players, with each player having his old beliefs for all nodes except node 3 (this follows from the independence of beliefs). For example, half of the player 1's who pass believe that player 2's take with probability $\frac{3}{4}$ and the other half believe that player 2's take with probability $\frac{1}{2}$. However, this profile is also a self-confirming equilibrium: player 1's who pass best-respond to the *actual* distribution of play σ^* as well. Player 3's believe that 1's and 2's pass with probability $\frac{1}{2}$, but still their action is optimal given the true distribution of play in nodes 1 and 2 and their beliefs about node 4. Therefore, when these players update their beliefs as they observe moves on the equilibrium path, this only reinforces their choices given their (fixed) beliefs for the nodes they never reach.

Clearly, $U^{PL}(\sigma^*) > U^{PL}(\sigma)$, since a greater mass of the population achieves $(4,4,0,1)$ under σ^*, and this result cannot be achieved with full information revelation.

Note that this showed the existence of a subset players, whose information sets are reached with positive probability under σ, and the behavior of which, if revealed, leads to a better self-conforming equilibrium for the planner. There are other subsets J that could achieve this result, such as $\{2,3\}$.

1.3.3 Strict Revelation Instability

In the following example, we once more assume that the planner maximizes social welfare. Consider Figure 1.3. The equilibrium described by the numbers in brackets is full revelation unstable. The problem is that after information about the behavior of player 2's is revealed, player 1's are indifferent between action B and C.

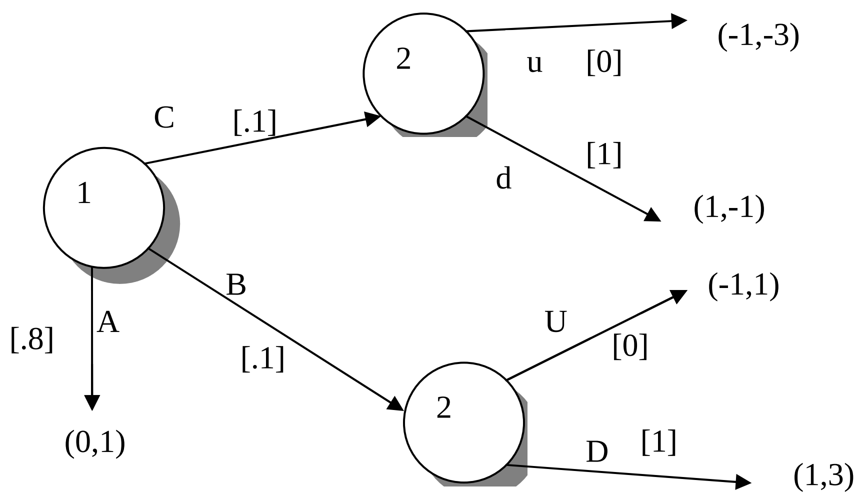

Figure 1.3
Game with a non-Strict Equilibrium

In particular, player 1's that choose A believe that a fraction $p_1 > \frac{1}{2}$ of player 2's choose u and a fraction $p_2 > \frac{1}{2}$ of player 2's choose U (given that the respective nodes are reached, of course). If the planner were to reveal the fact that, in both their nodes, player 2's choose the action that gives high payoffs to player 1's, then player 1's would not play A. But given the fact that they are now indifferent between choice B and choice C, it is not clear how they will play following the information release. In other words, their transition beliefs support multiple profiles. For information revelation to lead to a better social outcome, it is necessary that player1's choose action B, not action C. There is no obvious reason why these agents would choose this. Hence, the planner cannot guarantee that he will achieve higher payoffs with information revelation. Hence, the notion of revelation instability of this equilibrium is not as compelling as in our previous examples. Therefore, we define the following concept:

Definition 3 : A self-confirming equilibrium σ, supported by beliefs μ, is strictly partial-revelation-unstable relative to the planer's preferences, if there exists an information revelation set H^A on σ, such that for all profiles σ^* supported by H^A, the following hold:

a) σ^* is a self-confirming equilibrium, which for all i and for all $s^*_i \in$ support(σ^*_i), is supported by the transition beliefs $\mu_{s_i}{}^*$, generated by H^A, for all $h_j \in H_{-i} - \bar{H}(s^*_i, \sigma^*_{-i})$.

b) $U^{PL}(\sigma^*) > U^{PL}(\sigma)$.

c) $u(s_i^*, \mu^*_{s_i}) > u(s_i, \mu^*_{s_i})$, for some i, for some $s_i \in$ support(σ_i), and for some $s^*_i \in$ support(σ^*_i).

Information revelation can unambiguously lead to a better SCE for the planner in this case, regardless of the tie-breaking rule, because all possible new profiles are self-confirming equilibria and they are preferable for the planner. Note that if there are no indifferent agents given transition beliefs μ^*, a unique σ^* is supported by H^A, and revelation instability is strict.

1.4 Defending the Assumptions of the Basic Model

There are important implicit assumptions behind our basic model that should be defended. First of all, it seems that our agents are "naïve" in the sense that they do not understand that other populations will change their behavior after the announcements. We have already underscored the fact that more "sophisticated" agents who do not know the payoffs of other agents (including the planner) will behave in this manner as well. Secondly, it has been pointed out in seminars that it seems easier for the planner to directly reveal agents' utility, rather than their actions. We believe that this impression is simply wrong. Many of our important examples involve uncertainty about the moral incentives of agents, which are not directly observable. The notion of the planner revealing the utility function of officials in Example 1 seems nonsensical, but he may reveal their behavior.

Moreover, the informational requirements for the planner appear too strong. How does the planner know the moral payoffs in Example 1? Our answer to this question is based on revealed preference. If the planner can see in the aggregate data that all officials cooperate, he can infer their preferences. A seemingly stronger assumption is that the planner knows agents' beliefs. We argue that much can be inferred from the aggregate data about beliefs as well. In Example 2, there is a specific range of beliefs about opponents' actions that rationalizes the choices of player 1's and 2's who choose "take". To sum up, although some of our assumptions seem excessively strong, they are many important cases where they need not be so.

1.5 Revelation-Stable Equilibria and Socially Valuable Information

Definition: A self-confirming equilibrium is called "revelation-stable" if it is neither full revelation-unstable nor partial revelation-unstable.

A unitary self-confirming equilibrium is a mixed strategy profile σ such that for all i there exists beliefs μ_i such that for all $s_i \in \text{support}(\sigma_i)$, it holds that:

a) s_i maximizes $u_i(\cdot, \mu_i)$.

b) $\mu_i[\pi_{-i} \in \Pi_{-i} : \pi_j(h_j) = \hat{\pi}_j(h_j / \sigma_j)] = 1$ for all $j \neq i$ and $h_j \in \bar{H}(s_i, \sigma_{-i})$.

In other words, for such a self-confirming equilibrium, the same beliefs are used to rationalize all pure strategies of a given mixed strategy.

Proposition 1*:* All unitary self-confirming equilibria are revelation-stable.

Proof/ Let σ be a unitary self-confirming equilibrium supported by beliefs μ. If $h_j \in \bar{H}(\sigma)$, then $h_j \in \bar{H}(s_i, \sigma_{-i})$ for some $s_i \in \text{support}(\sigma_i)$, for all $i \neq j$. Hence, the initial beliefs μ_i must be correct for all $h_j \in \bar{H}(\sigma)$, and for all $i \neq j$. It follows that for any information revelation set H^A, the transition beliefs μ^* generated by H^A are the same as the initial beliefs μ. Clearly, then, there is no $\sigma^* \neq \sigma$ such that condition (e) of definitions 1,2 holds. *QED*

Theorem1is important for economic policy because it provides a justification for "selective affirmative action". By this term we mean the provision of incentives to special members of unrepresented social groups to try novel actions. These will "test" the ability of these agents to perform well in activities that they are expected to fail. The proposition shows that prejudice that totally prevents certain social groups from interacting with other groups is the most difficult to overcome. Persuading these members to experiment against their priors could generate socially desirable information, which, combined with selective information release, facilitates reaching a better social equilibrium. In Example 1, if people never invested, information revelation would not work. This result is similar with that of Jackson and Kalai (1997) who, in a setting where agents always observe aggregate information, argue that socially valuable information cannot be generated if people's priors are such that they never try a certain action. Hence, incentives should be given for experimentation against one's priors.

We will show by example that information revelation itself can lead to socially valuable information, causing the use of novel strategies. A strategy that was not used in the old equilibrium σ may be used after information revelation takes place. This provides a benefit to society additional to the higher payoffs associated with the new equilibrium.

Example 3. Consider the game illustrated in Figure 1.4, and the SCE $\sigma = \{(0.5L, 0.5R); R'; L''\}$. The beliefs are as follows: player 1's who play M believe that player 4's play L''' with probability $\frac{1}{2}$. Player 1's who play R believe that player 2's play L' with probability $\frac{5}{6}$, player 3's play R'' with probability $\alpha \geq \frac{1}{2}$, and player 4's play L''' with probability $\gamma \geq \frac{1}{2}$. L is not played at all in this equilibrium. However, if the planner announced the behavior of player 2's, then all player 1's who play R would switch to strategy L . In addition to the higher payoffs immediately achieved, this change would give information about the behavior of player 4's.

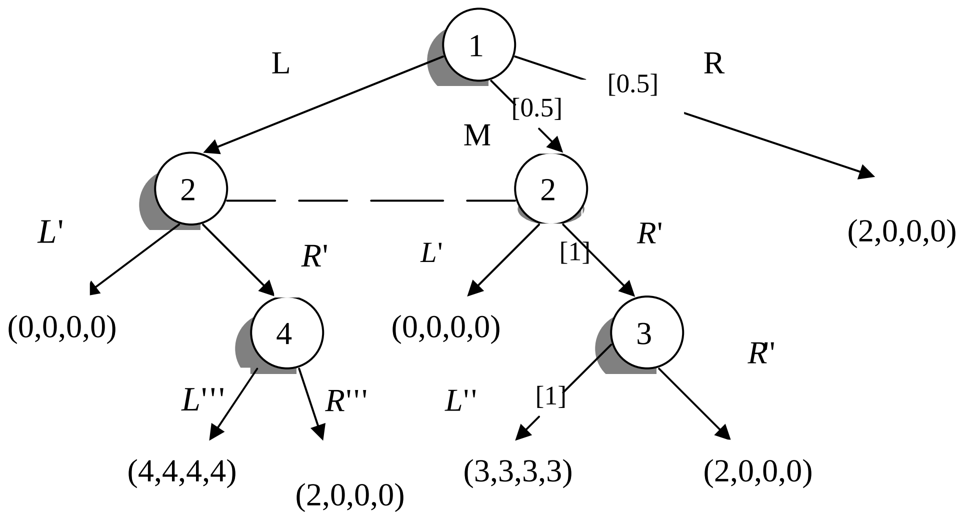

Figure 1.4
"The Dead Strategy Rise up Again" Game

Let Θ be the set of all extensive-form games that have a terminal node ψ with the following property: for every $i \in \mathrm{I}, \psi$ is the unique $\arg\max_{z \in Z} u_i(z)$. Let G be the set of all extensive-form games that have a terminal node ψ with the following property: ψ is the unique $\arg\max_{z \in Z} \sum_{i \in \mathrm{I}} u_i(z)$ and also the unique $\arg\max_{z \in Z} U_{\iota(y)}(z)$**,** where y is the immediate predecessor of ψ**.** Note that $\Theta \subset G$.

Definition: A game Γ is game of "monoambiguous choices", if for all players i and for all $h_i \in H_i$, there is at most one $\alpha' \in A(h_i)$ such that some $x \in \ell^{-1}(\alpha)$ is a decision node for some player. That is, for each player i and for all information sets $h_i \in H_i$**,** a terminal node immediately follows all actions, except (possibly) one. An example of such a game is the "beneficial superstition" game, where each player had at most one action that was followed by some decision node. Note that if Γ is a game of monoambiguous choices, all players have perfect information of other's moves.

Theorem. Let Γ be a game of complete information such that $\Gamma \in G$ and Γ is also a game of "monoambiguous choices"**.** Let σ be a strict self-confirming equilibrium of Γ such that $\psi \in \bar{Z}(\sigma)$**.** If, given σ**,** ψ is not reached with probability one, then σ is full revelation unstable.

Proof/ Clearly, all information sets in the game are singletons. Let $\overset{\angle}{\alpha}$ be the path of actions that leads to ψ**,** which is indexed by the precedence relation of the tree. Let $\iota(t)$ be the player that moves at the $t-$th step of the path, T be the total number of steps, and $\overset{\angle}{\alpha}(t)$ denote the action at the $t-$th step of the path. Let also $h^t_{\iota(t)}$ be the information set of player $\iota(t)$ where action $\overset{\angle}{\alpha}(t)$ is available. Notice that $\pi_{\iota(T)}(h^T_{\iota(T)}/\sigma)(\overset{\angle}{\alpha}(T)) = 1$ by the definition of G. Consider the set of all information sets of player i reached in the path to ψ**,** $H_i^{\overset{\angle}{\alpha}}$**.** If this set in nonempty**,** then the pure strategy $s_i[\overset{\angle}{\alpha}]$ that prescribes the choice of actions in $\overset{\angle}{\alpha}$ for all $h_i \in H_i^{\overset{\angle}{\alpha}}$ is optimal given beliefs that assign probability1 to the true distribution of actions induced by σ. The reason for this is that since ψ is reached with positive probability given σ, there are some player i's that choose pure strategy $s_i[\overset{\angle}{\alpha}]$. These players know the true σ, since because of the form of the game, the information sets on the path to ψ are the only ones reached with positive probability under σ. By "monoambiguous actions", it follows that they also know the exact payoffs they would get following any other strategy. Hence, for all players i that have a decision in the path to ψ,

$s_i[\overset{\angle}{\alpha}]$ is the optimal strategy when they know σ. Hence, following full information revelation, the welfare-maximizing node ψ is reached with probability one. Clearly this outcome is preferable to the planner than any other. *QED*

1.6 Self-Censorship: When is Concealing Information a Good Idea?

It is worth considering conditions under which the planner may not want to reveal all available information given a SCE σ. This issue is very important for economic policy because of the increasing influence of the media. As far as we know, economic theory has not explicitly addressed the issue of self-censorship.[16] We define "self-censorship" as the practice of not revealing available information regarding the aggregate data. In this section, we restrict ourselves once more to the case where the planner is a benevolent government and we argue that if, in certain cases, full aggregate information leads to negative social outcomes, then "self-censoring" makes sense. In the following paragraphs we shall try to characterize cases where "self-censorship" improves social welfare.

The beneficial superstition game is an example of the first type of games where full revelation of the existing information may be socially detrimental. In games like this,

[16] The main arguments in the social debate regarding the importance of self-censoring are philosophical. Indisputably, there are major philosophical questions here that are related to ethical values such as freedom. However, we argue that game theory can contribute to this debate as well, regardless of the great importance of the philosophical issues involved.

there is a social group whose welfare is maximized at a bad social outcome, and the interests of different social groups are conflicting. Roughly speaking, this special social group corresponds to “criminals” who appropriate the material payoffs of others. Example 2 reveals that “criminals” should not be fully informed. This agrees with common sense, which dictates that it is not a good idea to reveal information that shows that crime pays. Since the logic behind the need to conceal information is obvious in this case, we shall focus more on cases where the interests of social groups are aligned.

Example 4. The following example shows that even if a strictly Pareto superior outcome exists, and it is reached with positive probability, full information revelation may still not be optimal. Figure 1.5 illustrates a game with a Pareto dominant outcome, where all players earn 5. As usual, the numbers in the brackets show the fractions of each population following each strategy in the equilibrium σ. Note that the payoff-dominant terminal node is reached with positive probability. Player 1’s that choose L believe player 3’s play l' with probability $p_1 > 0.9$, player 1’s that choose R believe player 2’s play L' with probability $p_2 > 0.9$, and player 2’s that choose L' believe player 4’s play R'' with probability $p_3 > 0.9$.

Now, full information revelation will make the outcome $(3,3,3,3,3)$ be reached with probability equal to one. The reason for this is that, given the behavior of player 2’s, player 1’s had better choose R. However, if the planner only announced the behavior of player 4’s, then the payoff dominant outcome would be achieved 90% of the times, which is clearly better for society. In the following session, we shall try to generally characterize the classes of games where partial information is optimal.

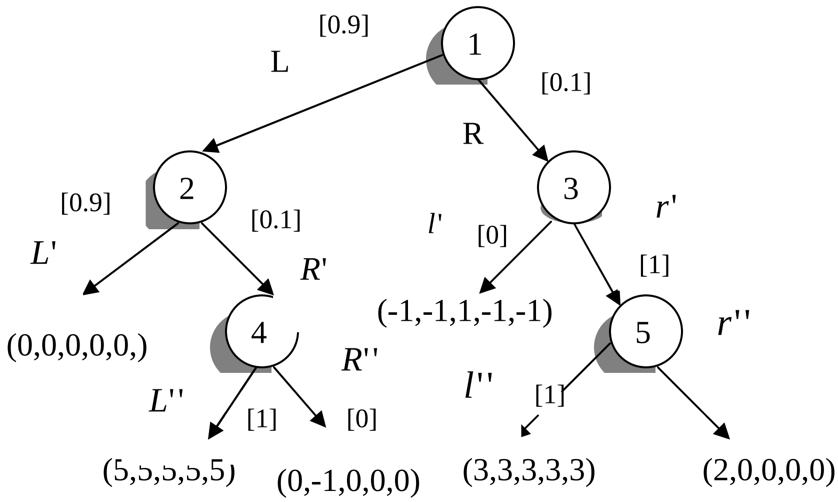

Figure 1.5
Game with a Payoff-Dominant Outcome

1.7 Partial-Revelation Improvable Self-Confirming Equilibria

For the following definitions, let σ be an information unstable self-confirming equilibrium supported by beliefs μ .

Definition: A (self-confirming equilibrium) profile $\sigma^* \neq \sigma$, which satisfies the conditions of definition 2 , is called an "information dominant" (self-confirming equilibrium) profile over σ **.**

Definition: The set $H_f^A = \bigcup H^A$ is called the "full revelation set" of σ.

Let K_σ be the set of all information dominant self-confirming equilibria over the SCE σ. Define $U_{\max}^{PL} \equiv \max_{\sigma' \in K_\sigma} U^{PL}(\sigma')$.

Definition: A self-confirming equilibrium σ is called "partial revelation improvable" if $U_{\max}^{PL} > U(\sigma'')$ for all σ'' supported by H_f^A.

In other words, a given SCE is "partial revelation improvable" if the optimal information revelation, given σ and μ, entails concealing some aggregate information.

Definition: Let σ be a SCE supported by beliefs μ. We call the beliefs generated by H_f^A "full-revelation transition beliefs".

Note that these beliefs need not assign probability one to the true behavior of opponents, given σ, for all information sets reached with positive probability under σ, because of the requirement of condition (2).

Now we shall examine whether partial information also makes sense in the setting where incentives of various social groups are more or less aligned. Can we identify classes of games where concealing information cannot be of use? As we shall see, it is truly the case.

Proposition 2. Let Γ be a game of complete information such that $\Gamma \in G$ and Γ is also a game of "monoambiguous choices". Let σ be a self-confirming equilibrium of Γ such that $\psi \in \bar{Z}(\sigma)$ and ψ is not reached with probability one given σ. Then, σ is not partial revelation improvable.

Proof/ This follows directly from the theorem.

Corollary: Let Γ be a game of perfect information and Γ is also a game of "monoambiguous actions". Let there be a terminal node ψ such that ψ is the strictly Pareto superior outcome. Let σ be a self-confirming equilibrium of Γ such that node ψ belongs to $\bar{Z}(\sigma)$. Then, σ is not partial revelation improvable.

Proposition 3. Let $\Gamma \in \Theta$ be a game of complete information. Let σ be a self-confirming equilibrium of Γ such that $\psi \in \bar{Z}(\sigma)$. Then, if σ is partial revelation improvable the following holds: For some player i who has a choice in the path to ψ, $\exists s_i \in \text{support}(\sigma_i)$ such that $u_i(s_i, \mu_i^{'}) > u_i(s_i(\overset{\angle}{\alpha}), \mu_i^{'})$ (4)

Proof/ If (4) was not true, then the best-response of each player to full information revelation would be to follow strategies $s_i(\overset{\angle}{\alpha})$, hence ψ would be reached with probability one. Clearly, there is no partial information revelation scheme that can achieve a better outcome. *QED*

However, the inverse is not true. That is, in SCE there may be strategies for which (4) holds, and still partial revelation cannot achieve better social outcomes than full information revelation. The two propositions restrict the scope of usefulness of self-censorship in game with a unique Pareto optimal outcome. Proposition 2 shows that self-censorship does not improve social welfare in a setting of monoambiguous actions, and proposition 3 identifies a necessary condition for self-censorship to be optimal. It is safe to argue based on our results that self-censorship is useful in a very wide range of games and not only in a small category.

1.8 Applications

Before we mention some specific examples where selective information revelation is used, it is worth emphasizing two points. First, there is a lack of explicit written discussion about policies that use selective information revelation to direct the behavior of the public. The reasons for this are easy to see: first of all, the information revealer does not wish to be criticized for manipulation of the public's behavior and self-censorship. Secondly, manipulation of expectations is more effective when it is covert. If the public knew about these policies, they would learn to understand when some information is missing, which would partly cancel the effects of selective information revelation. Because of these issues, the descriptive validity of our approach becomes more difficult to substantiate. It is also important to note that there are other important theoretical reasons to expect that aggregate information revelation can direct the behavior of the population, such as preferences for conformity.[17]

Governments follow implicit strategies of selective information revelation in some occasions. Authorities typically do not provide accurate data about those who

[17] A large literature in psychology explains where this type of preferences stems form. Theories of cognitive dissonance argue that a person's actions should agree with her perceived social role, otherwise they experience dissonance. Accordingly, prior to aggregate information revelation a person may tend to exaggerate the degree in which other people act the in the same way she does (this type of distortion of one's prior expectations has been substantiated and is called "false consensus"). Hence, if a person receives information that shows that her actions contradict the way she understands her social role, she may change her action in a way that resembles conformity. She may however simply discard the aggregate information if her preference for the given action is very strong.

escape capture. Consider the "beneficial superstition game" of Figure 1.2. 1's and 2's are two populations of investors who get a high benefit if they cooperate $(P1, P2)$. The group of player 3's are potential thieves who can grab part of the surplus $(P3)$ or not $(T3)$. Players 4's are police officers who may catch the criminal $(T4)$ or not $(P4)$. As we have seen, the planner should not reveal the distribution of actions of the police officers here. This is an example where society is better off when certain agents, whose "optimal behavior" entails significant externalities for others, are ignorant of the true distribution of actions.

Furthermore, governments' policies to mitigate social discrimination may involve selective information revelation when agreements with the media are reached. The media agree to refrain from emphasizing certain types of information for the good of the public. Revealing information that contradicts social stereotypes and concealing aggregate information that reproduces the stereotypes is a sensible and common strategy. A typical example of this is the extensive media coverage of the cases where women are performing jobs that are considered "men's jobs". In our interpretation, this may be done in order to change expectations about women's strategies in the population, and hence change others' optimal behavior when playing *against* a woman.[18] In some sense, therefore, selective information revelation is the management of self-fulfilling prophecies.[19]

[18] Preference for conformity of behavior within a social group also plays a major role here.
[19] See Hargreaves –Heap and Varoufakis (2002) for strong experimental evidence for this.

There are also significant applications related to discrimination, investor sentiments and elections. The media typically often deliberately try not to emphasize the behavior of people in the underclass, in order to avoid creating and rewarding antisocial behavior. Since many forms of antisocial behavior depend on the non-pecuniary social rewards that people receive from their peer groups and friends, information about the extent of such social phenomena should be handled carefully.[20] Moreover, policies aiming to protect investor sentiments often selectively conceal information. In most western countries after the Great Depression, novel institutions and policies were enacted to prevent pessimistic business sentiments from spreading. The notion that the stock market authorities may selectively reveal aggregate data in order to check investors' panic and promote optimism is acceptable. Furthermore, in some countries, the State restrains the use of public opinion polls during election periods. There is much evidence that voters like to vote for the wining party.[21] A specific political party, and special interest groups that support this party, may want to selectively reveal polls that show that the party is winning and conceal the ones that show that it is losing. Hence, in many countries there are restrictions on polls during the campaign period. [22]

[20] For example, according to a Dutch journalist, there is an implicit agreement in the Dutch press to refrain from overemphasizing the occurrences of sports violence and hooliganism, in order not to encourage potential new hooligans.

[21] This has been supported by many studies, and it is called "the bandwagon effect". Preference for conformity seems to be a major reason for this phenomenon.

[22] See Michalos, p. 410 and Morwitz and Pluzinski (1996), p. 53. The countries that have implemented or consider implementing a ban on political polling during election periods include Brazil, France, Canada and Germany.

The previous example made it clear that benevolent social planners may not the only ones who use selective information revelation to achieve their specific objectives.[23] Marketing behaviors are replete with similar manipulations of aggregate information. Advertising is a major example where information revelation is selective: the publisher of a book will promptly announce that the book has sold a million copies, but this not likely to be the case when it has only sold thirty-five copies.

At the same time, our analysis may be used to evaluate the consequences of various constraints that the ethical system of a society imposes on its government and special interests, shedding a different light on the social effects of restrictions and freedoms on public information revelation. For example, what are the results of the unlimited ability of the opposition parties in democracies to reveal data about corruption, undermining the public belief in the honesty of public officials? Shouldn't this effect be considered in the public debate? [24] We hypothesize that some sort of constraint of this ability may be beneficial for the economy.

1.9 Conclusions

We used an evolutionary framework with anonymous interactions to capture the capacity of aggregate information revelation to manipulate the behavior of the public. We showed that the "planner", who knows the aggregate information, can move the economy to his preferred equilibria by selectively revealing this information. However, social

[23] In fact, the "planner" need not even be unique. The two opposing parties may both reveal poll information, each to maximize its probabilities of winning.
[24] Thus, our approach contributes to the literature that examines the possibility that transparency may have some negative effects.

payoffs could be improved relative to a given self-confirming equilibrium, only if this equilibrium is heterogeneous. Further, concealing information can be optimal in certain cases. Finally, we presented a wide range of social phenomena which fits well with our approach.

The model could be extended in several different directions. Firstly, experimental evidence indicates that "social preferences" play a major role when aggregate information is revealed. Incorporating such preferences, especially "conformity preferences", in the model would be difficult but worthwhile. Secondly, using an explicitly dynamic approach would be fruitful, because it would allow us to examine the potential for many information revelations, rather than a single one. Moreover, in such an environment with multiple information revelations, it would be equally rewarding to study more sophisticated learning rules.

Chapter 2. Aggregate Information Revelation, Nash Equilibrium and Social Welfare: an Experimental Investigation

2.1 Introduction

Examining and deeply understanding the effects of aggregate information release in a society is very important for many different reasons. First of all, there is the fundamental question of whether aggregate information is beneficial for society. Will trust in the society promoted when people see others' behavior? Will people tend to become more or less morally responsible if they observe the aggregate data? Second, aggregate information release is usually considered exogenous, but we believe that the question of why aggregate information is revealed is of major economic interest. Possessors of aggregate information are typically special interests and governments who want to satisfy their own goals.[25] Moreover, older studies put forward important issues from a game-theoretical viewpoint. Fudenberg and Levine (FL) (1997) argue that agents' "passive learning" and wrong beliefs in equilibrium can explain behavior in many experiments of extensive-form games where no aggregate information is provided. Finally, Harrison and McCabe (HM) (1996) [26] assert that aggregate information causes

[25] For example, the seller of a product would like to know the optimal scheme of selectively revealing information about how his product sells, in order to maximize his profits. In a similar vein, the auctioneer is interested about what information about bids to reveal. Political parties also care whether opinion poll results affect voting behavior. All these special groups have an incentive to selectively reveal aggregate information to manipulate the behavior of the public in their desired way.

[26] They used information revelation of aggregate data to manipulate subjects' expectations in the ultimatum game. They find that information revelation leads to convergence to the subgame perfect equilibrium outcome, because it allows for consistency of expectations.

convergence to Nash equilibrium,[27] serving as a surrogate to the assumption of common knowledge of rationality. We examined all these issues by comparing the results of treatments with and without aggregate information. We found that aggregate information changes agents' behavior significantly, and its effects on aggregate welfare and convergence to Nash equilibrium can vary dramatically when there are small changes in the environment.

The experimental economics literature has seldom addressed the issue of aggregate information as its primary focus.[28] Most studies with aggregate information release have not confirmed the generality of the claim of HM regarding convergence to Nash Equilibrium. Moreover, some studies find that aggregate information increases total payoffs, while some other studies find the opposite. Berg, Dickhaut and McCabe (1995) performed experiments of one-round trust games[29] and found some support for the notion that information revelation of aggregate data increases aggregate payoffs and decreases the accuracy of the Nash equilibrium prediction. Dufwenberg and Gneezy (2002) reported the results of experimental auctions that resemble Bertrand price competition[30] and they found that full information revelation of the entire vector of bids tends to decrease the auctioneer's revenue, leading average bids away from the Nash equilibrium

[27] In our paper, when we refer to "Nash equilibrium" we mean Nash equilibrium with selfish preferences.

[28] Results from social psychology indicate that the information that a player receives about how other people behave matters for player's own behavior. There is a vast literature in social psychology regarding social influence, conformity, social norms and cognitive dissonance. For example, see Cialdini and Goldstein (2004) and Marks and Miller (1987).

[29] Each "sender" had 10$ that he could send to the receiver. The amount sent tripled, and then the receiver decided how much money to send back.

[30] Each subject was coupled with another person and chose an integer bid between 2 and 100. The subject that submitted the lowest bid won the auction and received a fixed monetary amount multiplied by the winning bid. The subject with the losing bid won zero, and if there was a tie the winner's amount was split. The fact that subjects were randomly matched is good for our comparisons.

outcome. Hargreaves–Heap and Varoufakis (2002) used a hawk-dove (symmetric) game, where subjects were split into two groups randomly, and they showed that revealing the aggregate distribution of actions of the two groups had a great impact on the evolution of play and on the distribution of payoffs. Finally, Frey and Meier (2004) found that revealing information about the fraction of the population that performs a certain charitable action tends to increase the frequency of this action in the population, improving social payoffs and moving aggregate play away from Nash equilibrium.[31]

The purpose of this paper is to provide further evidence for the effects of aggregate information, with a special emphasis on testing the ideas of FL and HM. We experimentally investigate the effects of aggregate information on the long-run aggregate distribution of actions in the centipede game, which is a two-person trust game where each player has two moves. In each move, a player chooses to "pass" or "take" and if he takes the game ends, while if he passes the total payoffs double and the other player takes the turn in choosing an action. The unique Nash and self-confirming equilibrium outcome, (which is, of course, the unique subgame-perfect equilibrium outcome), is where the first mover drops immediately. This outcome, which yields minimal social payoffs, has found very limited empirical support in previous studies.

To test how information revelation affects the evolution of play, we perform a series of experimental sessions of the four-move centipede game. Following our game-theoretical motivation presented in Chapter 1, we want to approximate a dynamic game of large populations with anonymous matching. Our experiments are designed

[31] However, it should be noted that this result obtained only when they revealed "optimistic" information about others' behavior, in the sense that the revealed fraction was relatively large.

accordingly, with each subject interacting with each opponent exactly once.[32] We examine several different forms of information feedback and two different payoff structures. In addition to the control treatment, we have "Information Treatments" where subjects can see the aggregate fractions of "pass" or "take" in every decision node in the immediately previous round. Information can be full or partial, with the latter implying that each subject of a particular group observes the fractions of the other group only.[33] Moreover, we examine the effects of information when we modify the payoffs slightly and far off the equilibrium path. In particular, in the "modified payoff" treatments, the monetary cost to player 2 of passing in the last decision node - and essentially offering to player 1 a large monetary amount - is slightly lower.

Our main result is that aggregate information revelation has large and significant effects on behavior and social payoffs, but the direction of these effects depends on the details of the game. With the initial payoff functions, "information" sessions typically converged to Nash equilibrium and total payoffs decreased significantly, contrary to the predictions of FL. Subjects' failure to coordinate when information is provided is even more surprising given the fact that information adds a dynamic aspect where "signaling" is possible. However, with the modified payoff function, information had a positive effect on total payoffs. Therefore, if we proposed a policy for maximizing aggregate payoffs, we would argue that it is *selective* information release, not merely aggregate information

[32] It is not possible to rule out repeated game effects totally, however, because players may realize they can affect the aggregate information that will be revealed in the future. This issue will be further discussed in part 8.

[33] Each group corresponds to a player-role in the game. This means that, with partial information, all subjects who have the role of player 1 only observe the fractions of behavior of subjects who are player 2's and vice versa.

or its absence, which has the optimal effect. In particular, our suggestions would be in the spirit of revealing "optimistic" information only. Our experiments help answer other important questions as well. We find that partial information revelation, where players observe play of the other population only, has similar effects with full information revelation. Moreover, when we replicate older treatments, our results are statistically different from those of the original experiments, and this might suggest a sample pool effect. We also show that aggregate information facilitates convergence to Nash equilibrium under some conditions and leads far from the equilibrium in some very similar ones; hence a general causal relationship between aggregate information and convergence to Nash equilibrium cannot be established. Finally, although we do not test a particular econometric model, we argue that theories of "conditional cooperation" account well for the results. "Selfish" preferences and "pure altruism" seem to be inconsistent with our findings.

Part 2.2 introduces the centipede game with exponentially increasing payoffs and discusses the results of previous experimental studies of this game. Part 2.3 briefly introduces all 12 sessions of our experiment. Part 2.4 discusses the basic hypotheses and the results in the first set of treatments, NIR and FIR.[34] In part 2.5 we consider alternative theories that may explain the basic results and thus we motivate the introduction of treatment PIR. The results of this treatment are presented in part 2.6 . Part 2.7 provides the theoretical motivation and the results of our last set of treatments, NIR-

[34] We shall describe extensively the details of these treatments when we introduce our experiments.

M and FIR-M. A detailed discussion of the results and their significance follows in part 2.8 . Part 2.9 concludes.

2. 2 The Centipede Game: Introduction and Previous Experimental Studies

In the two-player centipede game (Figure 2.1), two players share a monetary amount split into a large and a small pile, in a predetermined way for each terminal node. In each decision node, the player who moves can either “take” the large pile of money and the games ends, or pass” for next round. A player should always “take” now, if he expects that the other player will “take” in the subsequent move, but each player is better off passing now, if it is expected that the other player will also pass in the move after. In its finite version, the centipede game has an obvious candidate for a prediction of how it will be played: backward induction shows that in all Nash and self-confirming equilibria of the game, player 1 “takes” in the first move.

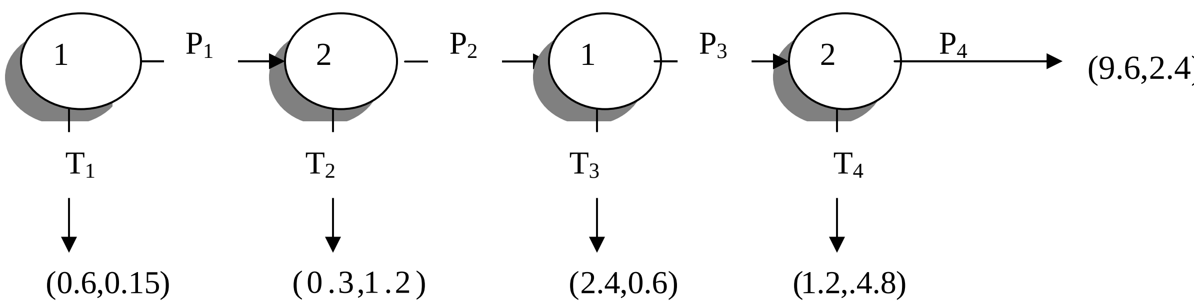

Figure 2.1 The Two-Player Centipede Game with Geometrically Increasing Payoffs

Experimental studies have found little support in favor of the Nash prediction, and it seems that subjects do not exclusively use backward induction and they do not assume full rationality of others when they try to predict others’ behavior. Most early experiments of the centipede game found very low frequencies of the predicted equilibrium outcome. (Note that here and in later parts we shall mainly refer to the last five rounds of experiments, where play is more likely to have converged to equilibrium). McKelvey and Palfrey (MP) (1992), in their classical experimental study of four-move and six-move centipede games, find that subjects "take" in the first decision node - which corresponds to the Nash equilibrium outcome - in no more than 8% of total matches. Fey, McKelvey and Palfrey (1996) find that, even in a setting of constant social payoffs, where the predictions of Nash, fairness and focal point theories agree in the same predicted outcome (where player 1 "takes" at move 1), players fail to achieve the equilibrium outcome 30 to 80 percent of the time, depending on the version of the game. Nagel and Tang (1998), using the equivalent normal form of the game, find relative frequencies of equilibrium play not exceeding 5%.

Other authors find more support for Nash equilibrium play by changing the basic features of the game, usually confounding more than one such change. Stein, Rappoport, Parco, and Nicholas (2003) find that equilibrium play is chosen 30 to 40 percent of the time in an experiment where each "inning" of choices involved three players rather than two, stakes were much higher on average and the last terminal node gave zero payoffs to all players. Murphy, Rappoport and Parco (2006) use a continuous-time version of the centipede game, and they show that, with three players, games finish early in late rounds; hence there is evidence of strong convergence to equilibrium. With seven players, convergence is complete in all sessions.

2.3 The Experiment

Twelve experimental sessions were conducted at the California Social Science Experimental Laboratory (CASSEL) at UCLA. All subjects were UCLA students and the vast majority was undergraduate students. Each person was only allowed to participate in a single session. There were nine sessions with $n = 30$ (n is the number of participants), two sessions with $n = 28$ and one session with $n = 26$. Each subject played $\frac{n}{2}$ rounds of the four-move centipede game allowing for many repetitions and learning. Subjects also had the chance to gain experience with the game during three practice sessions. The relatively large number of participants somewhat mitigated the effects of repeated games and signaling that information revelation made possible. The matching scheme was the same as in MP (1992). A rotating matching scheme was used, and the subject pool was divided into two groups of $\frac{n}{2}$, the composition of which was fixed throughout the experiment.[35] Each participant was matched with each member of the other group exactly once. All information about the structure of the game and the matching details was made public knowledge to subjects, since the instructions were read in public. Subjects were paid the full amount that they accumulated in all real rounds and each monetary unit corresponded to one dollar. Subjects did not have particular difficulties understanding the game, and also had many opportunities to learn during the practice rounds and the repetitions of the game. Appendix 2 contains the instructions for treatment FIR.

[35] For our subjects, the two groups were labeled the GREEN group and the YELLOW group. The members of the GREEN group always had the role of player 1 in the centipede game and the members of the YELLOW group always had the role of player 2.

Table 2.1 shows the basic features of all 12 sessions. The game played in the first seven sessions was exactly the one described in Figure 2.1. These sessions, therefore, had the same "relative payoffs" as in MP, but dollar payoffs were 50% higher at every terminal node. In two of the sessions, the treatment was called "No Information Revelation" (NIR1 and NIR2). This was essentially the same treatment as in the four-move centipede experiments of MP. In sessions FIR1 and FIR2 the treatment was called "Full Information Revelation" and subjects received information about how the members of both groups played in the previous round. In particular, during any round, all subjects saw the fractions of "pass" and "take", in each of the decision nodes of the game, in the previous round.[36] For example, during the tenth round, in the first decision box, all subjects saw the fraction of the members of the GREEN group that chose "pass" or "take", in this particular node, during the ninth round. In the second decision box, all subjects saw the fractions of the members of the YELLOW group that chose "pass" and "take", in this node, in the ninth round. Similarly, subjects saw the respective information for all other nodes.[37]

In sessions PIR1, PIR2 and PIR3, the treatment was called "Partial Information Revelation". The same kind of information as in treatment FIR was provided, but only for the "opposite" group. For example, all GREEN subjects in round 5 were shown the fractions of the YELLOW group of people that chose "pass" or "take", in the fourth round, in all nodes where YELLOW moves. Subjects could not see the fractions in nodes

[36] Remember that each node belongs to members of one group only.

[37] Of course, since not all nodes were reached in each match, subjects saw information only about those matches that reached in each particular node in the previous round.

where their own group moves. We will call sessions with full or partial information release "information" sessions.

In the last five sessions shown in Table 2.1 payoffs were slightly modified. In particular, subjects played the game shown in Figure 2.2. Two of the sessions with modified payoffs, NIR1-M, NIR2-M did not involve information revelation. The other three sessions with modified payoffs were full information revelation sessions, with "full information" having the same meaning as above.

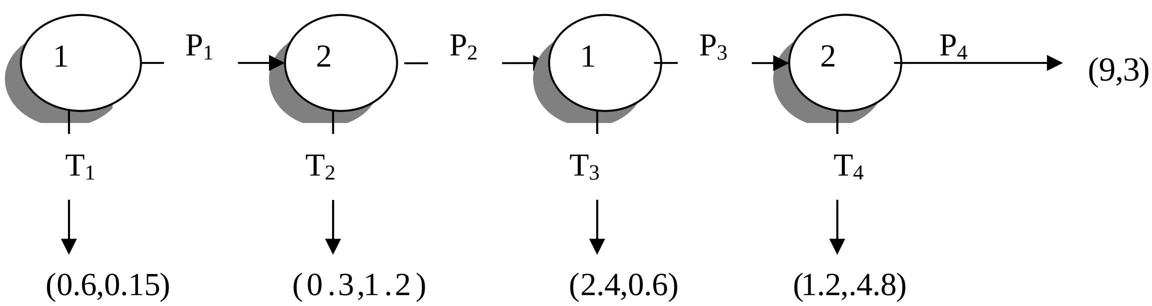

Figure 2.2 The Two-Player Centipede Game with Modified Payoffs

Session Name	**Number of subjects**	**Aggregate Information**	**Number of Matches**	**Payoffs**
NIR1	30	NO	225	Similar with MP
NIR2	28	NO	196	Similar with MP
FIR1	30	FULL	225	Similar with MP
FIR2	30	FULL	225	Similar with MP
PIR1	30	OTHER GROUP ONLY	225	Similar with MP
PIR2	28	OTHER GROUP ONLY	196	Similar with MP
PIR3	30	OTHER GROUP ONLY	225	Similar with MP
NIR1-M	30	NO	225	Modified
NIR2-M	26	NO	169	Modified
FIR1-M	30	FULL	225	Modified
FIR2-M	30	FULL	225	Modified
FIR3-M	30	FULL	225	Modified

Table 2. 1 Characteristics of Each Experimental Session

2.4 Treatments NIR and FIR: The Basic Hypothesis and Results

Our principal hypothesis concerns comparison of play with and without aggregate information, and testing it was the major motivation for using the centipede game. The results in MP show that enough "passing" (18%) exists in the last decision node to make it worthwhile for all agents to pass in early nodes. Fudenberg and Levine (1997) argue that that the results of MP can be explained as equilibrium behavior with respect to heterogeneous beliefs about the distribution of opponents' actions. That is, for each population-group that plays a specific equilibrium strategy, beliefs need not be correct for nodes not reached for the specific group, given its strategy[38]. Hence, if subjects knew the aggregate fractions in the experiments of MP, they would optimize by passing all the way until at least the last decision node. We wish to follow FL's suggestion to compare treatments with full information revelation of aggregate play with treatments where people only observe play in their own matches.[39] We expect that with information about others' behavior, the aggregate distributions of play will have a higher mass in late terminal nodes and subjects will, on average, make higher payoffs.[40]

Hypothesis 1: Full information revelation results in higher average payoffs for subjects. We test for equality of average payoffs in treatments NIR and FIR, rounds 11-15, and observe the direction of the possible difference.[41]

Appendix 1 contains descriptive data for all sessions.[42] Figures $2.3-2.6$ display the fraction of total matches that ended in each of the five terminal nodes in our two

[38] The only part of the data that cannot be explained according to this theory (with selfish preferences) is some YELLOW subjects' choice of "pass" in the last decision node.

[39] FL's theory implies that selective information revelation of aggregate data matters, even in equilibrium. If people are "trapped" in a specific strategy and wrong beliefs, due to their strong priors and lack of experimentation, then, in the face of information revelation about the aggregate statistics, their expectations could change in a predictable way. This leaves the door open to manipulation of people's behavior by those who possess the aggregate information.

[40] Note that because of the exponential form of the payoffs of the game, average payoffs are a good approximation of the degree to which subjects "trust" others and tend to "pass".

[41] Note that a very important prerequisite for this argument to hold is that subjects' behavior *in the last decision node*, when information is provided, will remain the same as in the original data of MP. In other words, we believe that there no important a priori reason to expect that information revelation will reduce YELLOW subjects' incentives to pass in the last decision node and "give away money" to others. If anything, since subjects may realize that signaling is possible, we would expect information release to lead to more passing, not less.

[42] We use the notation of Figure 2.1 to describe the data. We describe each terminal node with the last action required to reach that node. Accordingly, terminal nodes are denoted $T1$, $T2$, $T3$, $T4$ and $P4$.

treatments, NIR and FIR, in rounds $1-15$ and in rounds $11-15$. There are 225 matches in each fifteen-round session and 196 matches in each fourteen-round session. The data from all sessions of a given treatment are pooled. Thus, there are 421 observations for treatment NIR and 450 observations for treatment FIR in rounds $11-15$. Figures 2.3 and 2.5, where the data from all 15 rounds are pooled, show a relatively small difference between the aggregate distributions of play in treatments NIR and FIR. Figures 2.4 and 2.6, which show the similar data for the last five rounds of play, reveal larger differences. For example, the fraction of total matches that end in the Nash equilibrium outcome is about 50% for FIR and about 33% for NIR.

The effect of information revelation was in the opposite direction than the one hypothesized. In fact, hypothesis 1 is overwhelmingly rejected by the data. The mean payoff per match in rounds $11-15$ of treatment NIR is 2.13 and in the same rounds of FIR the mean payoff is 1.4. The t-test of differences in means with unequal variances rejects the null hypothesis of equal payoffs (two-tailed p-value= 0.0004), but in the opposite direction from the one expected! We believe that this result is due to subjects' specific social preferences. In part 2.5 we discuss and examine possible types of preferences that explain our results.

Our data share some of the main features of previous experiments of the centipede game. In particular, one major stylized fact from these experiments is that the conditional "take" probabilities[43] increase as we move from the first to the last decision node of the game. In our data, this was true for all four sessions and all decision nodes. However, in

[43] For a decision node, the "conditional take probability" is the fraction of people who chose "take" in this node in the experiment, from all the players that moved in this node.

the FIR treatment there are some substantial new features. First of all, convergence to the Nash equilibrium outcome (T1) is very strong in late rounds, much stronger than in MP. To make statistical tests, we assume that in the last five rounds play has converged, and therefore each observation is independent of the others. Table 2 contains the results and p-values of most of the statistical tests and we shall frequently refer to it. We can see that the higher frequency of Nash equilibrium play in FIR relative to NIR is statistically significant. Moreover, the whole distributions differ substantially and the chi-square test shows that this difference is significant. Hence, we can safely conclude that subjects' behavior is different when full information is provided.

Moreover, subjects seem to behave differently than in the experiments of MP. In the two sessions of the control treatment, NIR1 and NIR2, a large fraction of matches in rounds $11-15$ ends in the Nash equilibrium outcome (29% and 37%) and the corresponding fraction is very similar in rounds $6-10$ (29% and 38.5%). This is much larger than the equilibrium fraction found by MP in rounds $6-10$ (8%). We examine the difference in the distributions of the pooled data from the NIR sessions, rounds $6-10$, with the pooled data from the three 4-move sessions of MP in the same rounds (the data are in Appendix1). Using a chi-square test, we overwhelmingly reject the null hypothesis of homogeneity, so UCLA subjects seem to exhibit different behavior than Caltech and PCC students, since it is clearly not the number of rounds that makes the difference. UCLA has a much larger pool of potential subjects than Caltech and hence there may be a subject pool effect.

Another very interesting aspect of the data is that in treatment FIR, very few YELLOW subjects chose "pass" in the last decision node. This seems to be the key reason for the fact that our theoretical predictions failed, and it will be discussed later, together with possible explanations. To test whether these differences are statistically significant, we make the strong assumption that behavior in the last decision node does not depend on the round of the game. This is necessary for getting a sample large enough.[44] Hence, we pool all the data from all rounds. Table 2.3 contains all the statistical results of tests which use data from all rounds of play, $1-15$. We first perform a simple test of differences in proportions, pooling all terminal nodes except $P4$ in one category. We find that a significantly higher fraction reaches the last terminal node in NIR (0.028) relative to FIR (0.0067).

A well known weakness of z and chi-square testing, which we have been using so far, is when some category has very low "expected frequency".[45] Therefore, because of this problem in category $P4$, we will also perform Fisher's exact test whenever the expected frequencies for any category are very low and the contingency table is $2x2$. Using this test for comparing the last-node proportions in the NIR (N$=421$) and FIR

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[44] Performing the test for the data of the last five rounds only, the z-value we get is -1.86 and the two sided p-value is 0.062. Not only does our test have very low power, but also expected frequencies in the last terminal node are extremely low, which casts doubt on the results of tests based on asymptotic distributions.

[45] There is a large debate in the statistical literature about which test is appropriate for testing hypotheses in contingency tables for small and intermediate sample sizes. Conventional knowledge is that Fisher's exact test is the more appropriate for small samples and chi-square tests for large samples. However, several authors question this, and claim that the uncorrected Pearson chi-square test should be used in small samples. See d'Agostino et al (1988). Cochran (1954) also claims that the chi-square test can be used even when expected frequencies are small: "*…the chi-square tables are an adequate approximation to the exact distribution even when some* m_i *are much lower than* 5." See also Sahai and Khurshid (1995) for an excellent review of appropriate methods for testing hypotheses in contingency tables depending on the specific sampling method.

($N=450$) we also find the difference statistically significant (see the results in Table 2.3). Thus, we conclude that a higher fraction of total matches ends in the last terminal node when no information is provided.

However, a better metric of last-node behavior is the conditional “take” probability at the last decision node (YELLOW’s second node), given that this node has been reached. The conditional take probability in this node for rounds $1-15$ of treatments FIR and NIR is 94.2% and 78.2% respectively. To test for the statistical significance of this difference, we consider the sample of all matches that reached the last decision node, and test for differences in the proportion of those who passed. ($N_{FIR} = 52, N_{PIR} = 55$). Both χ^2 and Fisher’s exact test indicate that the difference is statistically significant. We conclude that providing aggregate information changed subjects’ behavior in the last decision node, and this reduced passing in general.

Object Tested for Equality Across Treatments, R. 11-15	**Treatments**	**Test Statistic**	**P-Value**
Fraction of T1	NIR(0.33) and FIR(0.5)	z=2.77	0.0054
Fraction of T1	NIR(0.33) and PIR(0.4)	z=1.32	0.18
Fraction of T1	FIR(0.5) and PIR(0.4)	z=1.55	0.084
Fraction of T1	NIR(0.33) and NIR-M (0.096)	$\chi^2 = 20.0$	<0.0001
The whole distribution	NIR and FIR	$\chi^2 = 14.89$	0.004
The whole distribution	NIR and NIR_{MP}	$\chi^2 = 35.8$	<0.0001
The whole distribution	NIR, FIR and PIR	$\chi^2 = 15.02$	0.0587
The whole distribution	NIR and PIR	$\chi^2 = 2.98$	0.56
The whole distribution	FIR and PIR	$\chi^2 = 6.81$	0.14
The whole distribution	NIR and NIR-M	$\chi^2 = 26.47$	0.0003
The whole distribution	NIR-M and FIR-M	$\chi^2 = 14.51$	0.0058

Table 2.2. The Results of Statistical Tests Comparing Data in Rounds 11-15

Object Tested for Equality Across Treatments, R. 1-15	**Treatments**	**Test Statistic**	**P-Value**
Fraction of P4	NIR(0.028) and FIR(0.0067)	Fisher	0.017
Fraction of P4	NIR (0.028)and FIR(0.0067)	z=2.47	0.013
Fraction of P4	NIR(0.028) and NIR-M(0.045)	$\chi^2 = 1.69$	0.19
Fraction of P4	NIR(0.028) and PIR(0.007)	Fisher	0.011
Fraction of P4	NIR-M(0.045) and FIR-M(0.091)	$\chi^2 = 7.65$	0.0056
P4/(T4+P4)	NIR(78.2%) and FIR(94.2%)	$\chi^2 = 5.7$	0.017
P4/(T4+P4)	NIR(78.2%) and PIR(91.6%)	$\chi^2 = 4.1$	0.042
P4/(T4+P4)	NIR(78.2%) and PIR(91.6%)	Fisher	0.064
P4/(T4+P4)	FIR(94.2%) and PIR(91.6%)	$\chi^2 = 0.27$	0.6
P4/(T4+P4)	NIR, FIR and PIR	$\chi^2 = 7.7$	0.021
P4/(T4+P4)	NIR(78.2%) and NIR-M(84%)	$\chi^2 = 0.923$	0.336
P4/(T4+P4)	NIR-M(84%) and FIR-M(69%)	$\chi^2 = 8.7$	0.0031

Table 2.3 The Results of Statistical Tests Comparing Data in Rounds 1-15

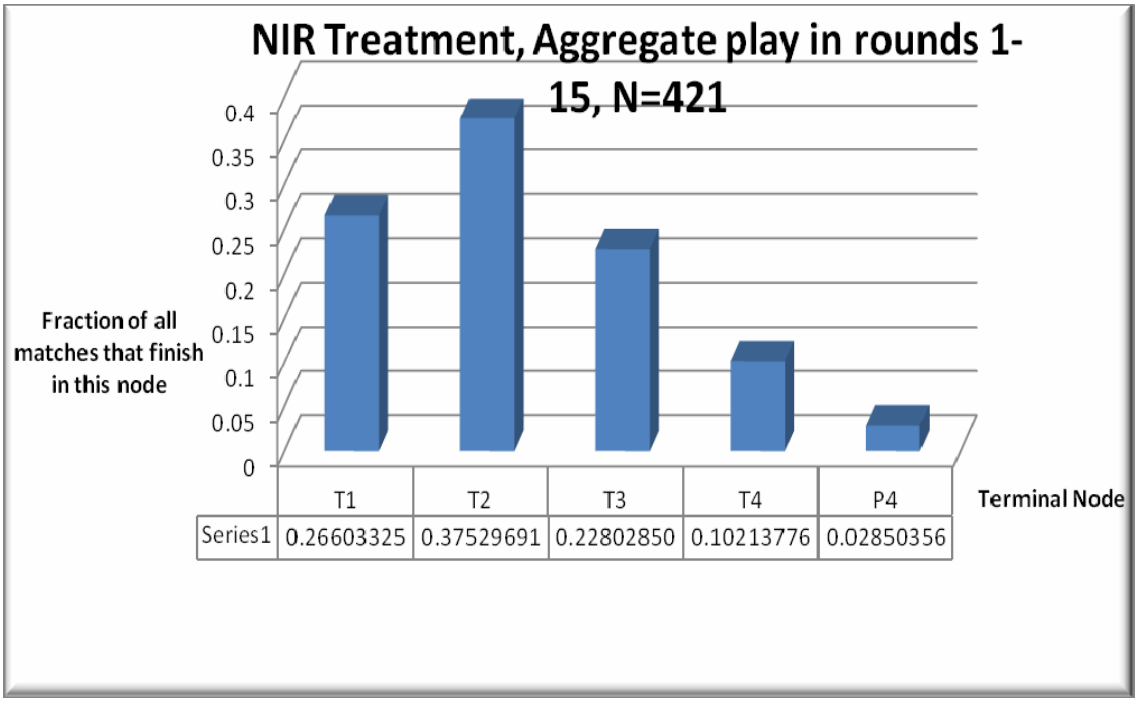

Figure 2.3 Fractions of Rounds in each Terminal Node, Treatment NIR, Rounds 1-15

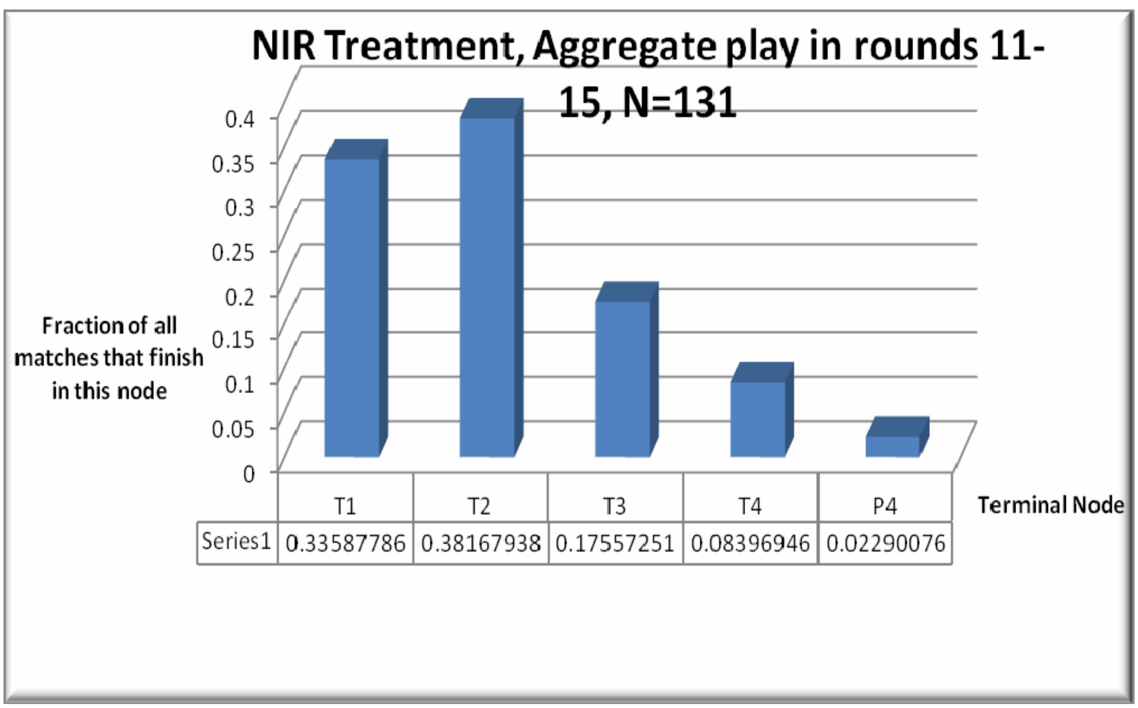

Figure 2.4 Fractions of Rounds in each Terminal Node, Treatment NIR, Rounds 11-15

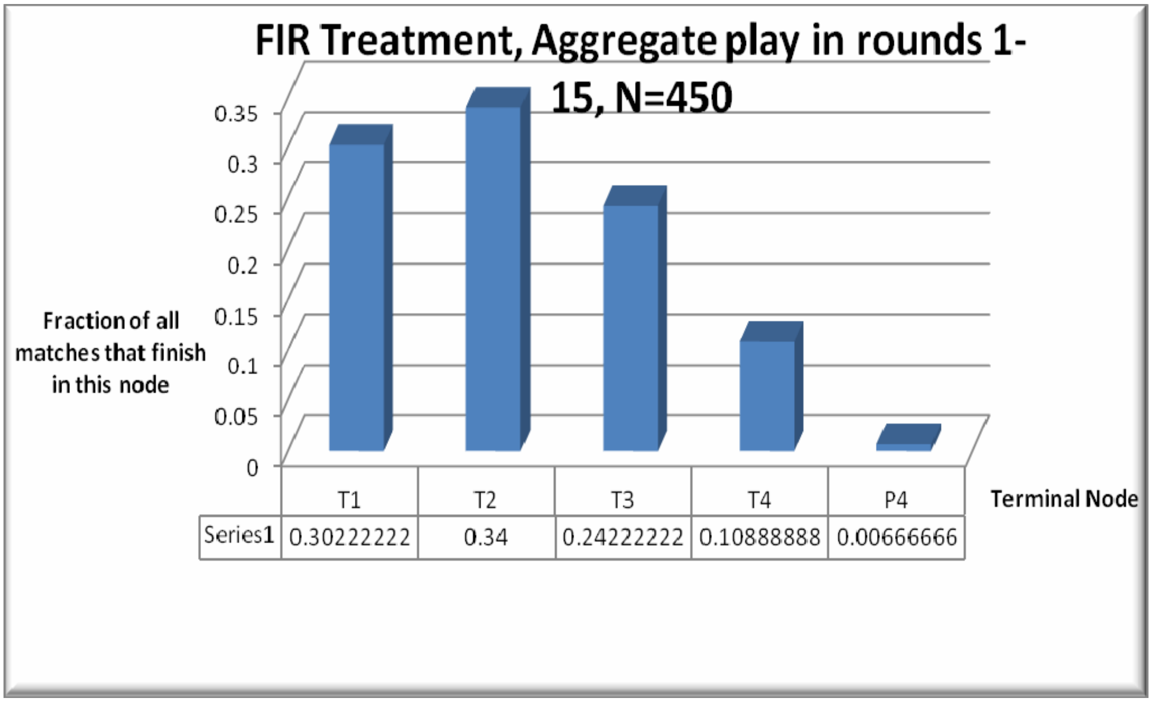

Figure 2.5 Fractions of Rounds in each Terminal Node, Treatment FIR, Rounds 1-15

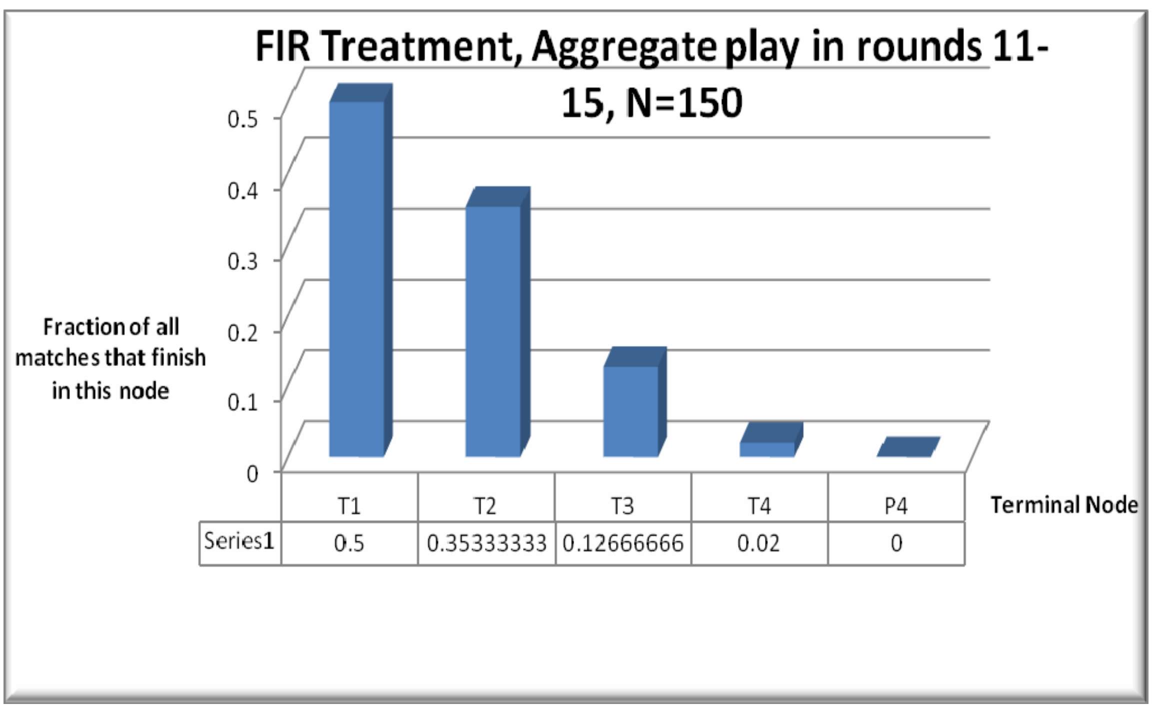

Figure 2.6 Fractions of Rounds in each Terminal Node, Treatment NIR, Rounds 11-15

2.5 Alternative Explanations for Behavior in the Last Decision Node

The most intriguing feature of the data in treatments NIR and FIR was the rejection of hypothesis 1, which was largely due to the fact that very few matches exhibit passing at the last decision node. The choice of YELLOW subjects in the last decision node cannot be affected by aggregate information if they have standard preferences, because monetary payoffs from choosing any alternative at this node are given. (Also, as we explain in part 8, subjects did not use much signaling in treatment FIR). Furthermore, if "pure altruism" could explain YELLOW subjects' last-node passing behavior, and if people had a fixed preference for altruism, we would expect similar "take" probabilities in the last decision node in all treatments.[46] Consequently, a "reciprocal altruism", "conformity" or analogous "conditional coordination" interpretation needs to be invoked in order to explain the behavioral change.

Subjects may tend to conform to the conduct of other people that belong in the same group as they do. If a social norm evolves that player 2's do not pass in the last decision node, then others follow this. There is a large literature on peer effects, which underlines the positive relationship between the actions of an individual and the behavior of members that belong to his peer group. Conformity preferences characterize an agent who likes to follow the actions that the majority chooses. This type of preferences could be described by the following rule: each subject has a "threshold" regarding the fraction

[46] This discussion is assuming that subjects do not realize the usefulness of signaling and they do not employ it. We believe that our results in the "information" treatments support this assumption so we will not defend it any further.

of members in his peer group that follow some action.[47] If the actual population fraction, according to the subject's beliefs, is larger than this threshold, the specific subject also follows this action. If the perceived fraction is less than the threshold value, the person refrains from performing the action.[48]

Without aggregate information, YELLOW people have a prior belief about their own population fractions of "pass" and "take", and their last-node play depends on their beliefs and their threshold. Perhaps some subjects overestimate their own population fraction of "pass". In other words, without aggregate information, many subjects may pass in the last decision node because they mistakenly believe that a large fraction of others in their group also does so. However, after they get to see that only few YELLOW subjects behave like this, they no longer want to pass because they do not want to belong to a small minority. We call this the "peer-group conformity" interpretation.

Another possible explanation could be provided by theories of reciprocity, such as Levine's (1998) model where subjects tend to be generous when they interact with "altruistic" people and to be mean towards "spiteful" opponents. An explanation using this model is along the lines of the arguments presented in the previous paragraph: without aggregate information, people have a prior belief on the distribution of altruism in the population, and their play depends on what type of player they expect they are matched with. It is plausible that some altruistic subjects' priors overestimate the

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[47] Especially if this action involves the tradeoff between material well-being and acting morally.
[48] See Frey and Meier for an argument along these lines.

population probability that an opponent is an altruist.[49] If this is true, information revelation of aggregate play shows to such "altruistic" persons that the truth is different that they think, and they adjust their actions accordingly. We call that the "reciprocity" interpretation. Note that psychological game theory can provide a similar explanation in terms of social expectations. If the revealed data show that opponents expect people in "my group" to behave in a non-reciprocating way, I may as well behave like they expect. However, if I am expected to pass, I suffer a disutility from disappointing their expectations.[50]

2.6 Treatment PIR: the Basic Hypotheses and Results

We introduced treatments PIR1, PIR2 and PIR3 in order to examine more carefully the non-strategic reasons for the change in subjects' behavior when aggregate information is provided. Assuming that the "peer-group conformity" interpretation is valid, play in the last decision node should be affected only by information about what other subjects of the same group do at this decision node. Accordingly, we would expect that the behavior of YELLOW subjects in the last decision node, when no information about the behavior of their peers is provided, would be similar to behavior in NIR. Furthermore, if this is true, then with partial information revelation of the "other" group only, we should expect high payoffs and passing behavior. In other words, the reasons for convergence to the Nash equilibrium, as specified in part 2.5, should no longer hold.

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[49] The notion of "false consensus" in psychology describes people's tendency to believe that other people are similar to them. See Marks and Miller (1987).

[50] See for example the model by Battigalli and Dufwenberg that captures how guilt affects behavior.

Hypothesis 2 : Partial information revelation leads to higher average payoffs than no information revelation. We test for the equality of average payoffs in treatments PIR and NIR.

Hypothesis 3 **:** In treatment PIR, the conditional "take" probability at the last decision node does not differ from treatment NIR.

Our results provide limited support to the idea that not revealing the behavior of the "own" group tends to mitigate the negative effects of aggregate information on social payoffs. Average payoff per match in rounds $11-15$ of treatment PIR is 1.79, which is somewhat higher than in FIR but also lower than in NIR. The t-test for equality of means in NIR vs. PIR with different variances has a two-tailed p-value 0.129. Hence, partial information revelation tends to decrease average payoffs, not to increase it, but the result is not statistically significant. However, partial information seems to have less of a negative effect than full information, since the average payoffs in PIR are significantly higher than in FIR (t-test, two tailed p-value= 0.0055). Clearly, session PIR 1, where average payoffs were much higher than in sessions PIR 2 and PIR 3, is largely responsible for this (see the data in Appendix 1).

The distribution over terminal nodes in PIR is, in some sense, "between" the distributions in NIR and PIR. Figures 2.7 and 2.8 display the distribution over terminal nodes for rounds $1-15$ and for rounds $11-15$ (the total number of matches in treatment PIR is 646). These results do not differ very much from the results of FIR, but they do tend to be closer to the results of NIR. The test for homogeneity of distributions in nodes $11-15$ for all three treatments, NIR, FIR and PIR cannot reject the hypothesis of homogeneity. Similarly, the pairwise differences in distribution between NIR and PIR and between FIR and PIR are not statistically significant (Table 2.2). Furthermore, the fraction of matches that result in equilibrium play (the first terminal node), in rounds $11-15$, does not statistically differ in treatment PIR from the analogous fraction in the other treatments.

Is hypothesis 3, which claims that partial information revelation cannot affect "last-decision node" behavior in the same negative way as full information revelation, supported by the data? Clearly, it is not so. The "conditional take probability" in this node in all rounds of treatment PIR is 91.6%, which is very similar to the fraction 94.2% of treatment FIR, and much higher than the fraction 78.2% of treatment NIR. Hypothesis 3 is rejected, because the test of homogeneity of last-decision node behavior in treatments NIR and PIR yields $\chi^2 = 4.1$, p-value$=0.042$. Moreover, the test for homogeneity of the last-decision-node conditional take probabilities across all three treatments NIR, PIR and FIR rejects the null hypothesis at the 5% level.

However, partial information release does not seem to have a different effect on behavior in the last decision node than full information release, since the difference in the conditional take probabilities in the last decision node in treatments FIR and PIR is not significant. Furthermore, the proportion of total matches that end in the last terminal node in treatment NIR is significantly larger than in PIR. It is safe to conclude that both full and partial information revelation result in higher conditional "take" probabilities and a lower fraction of matches that end in the last terminal node.

The large difference in aggregate play between session PIR1 and sessions PIR2 and PIR3 is also of interest. It seems that only in session PIR1 subjects behaved in the predicted way: behavior in the last decision node did not change much compared to the NIR treatment, and average payoffs were high. This implies that the "peer-group conformity" theory might have some bite. On the other hand, play in sessions PIR2 and PIR3 evolved as in FIR. One explanation for the disparity among the sessions of the PIR treatment is that round-per-round information revelation causes play to be path-dependent. This will be discussed later, since there are also important differences within the sessions of treatment FIR-M.

2.7 Treatments NIR-M and FIR-M: The Basic Hypotheses and Their Theoretical Underpinnings

Recall that in the Modified Payoff treatments, YELLOW subjects who "pass" in their last decision node have somewhat higher monetary payoffs than before (3 instead of 2.4). We use the modified payoff treatments in order to examine whether aggregate information release can be beneficial for social welfare in a setting very similar to FIR, where aggregate information has been proven to be detrimental for social welfare.

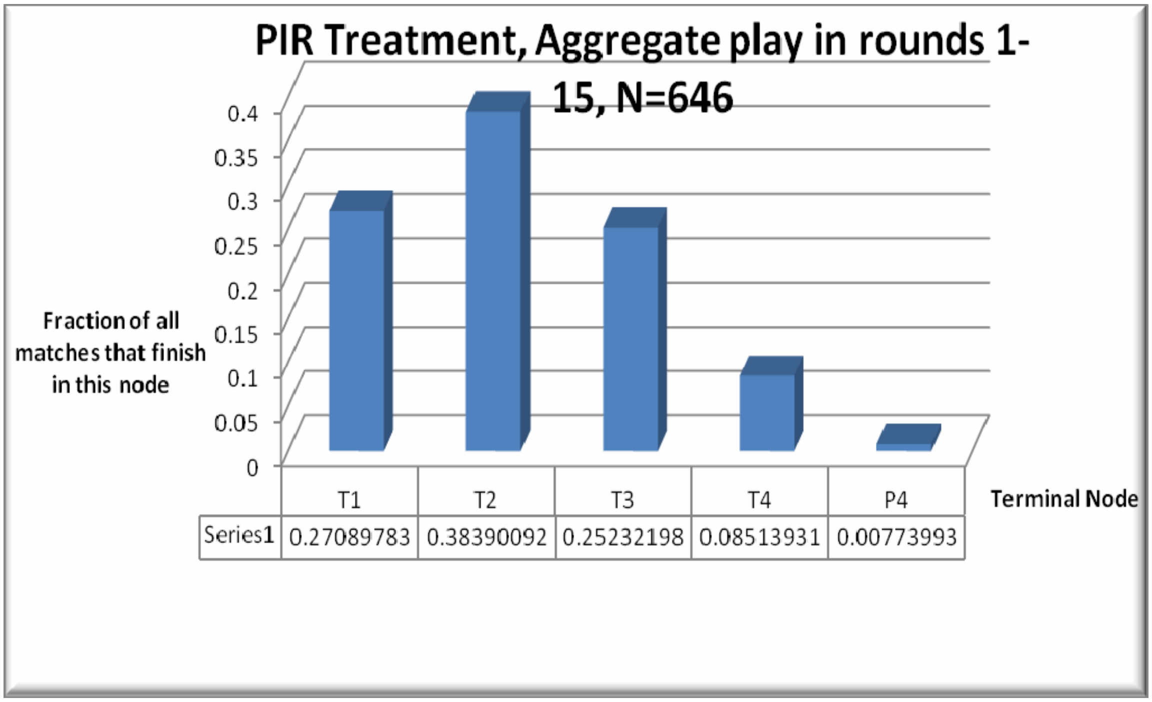

Figure 2.7 Fractions of Rounds in each Terminal Node, Treatment PIR, Rounds 1-15

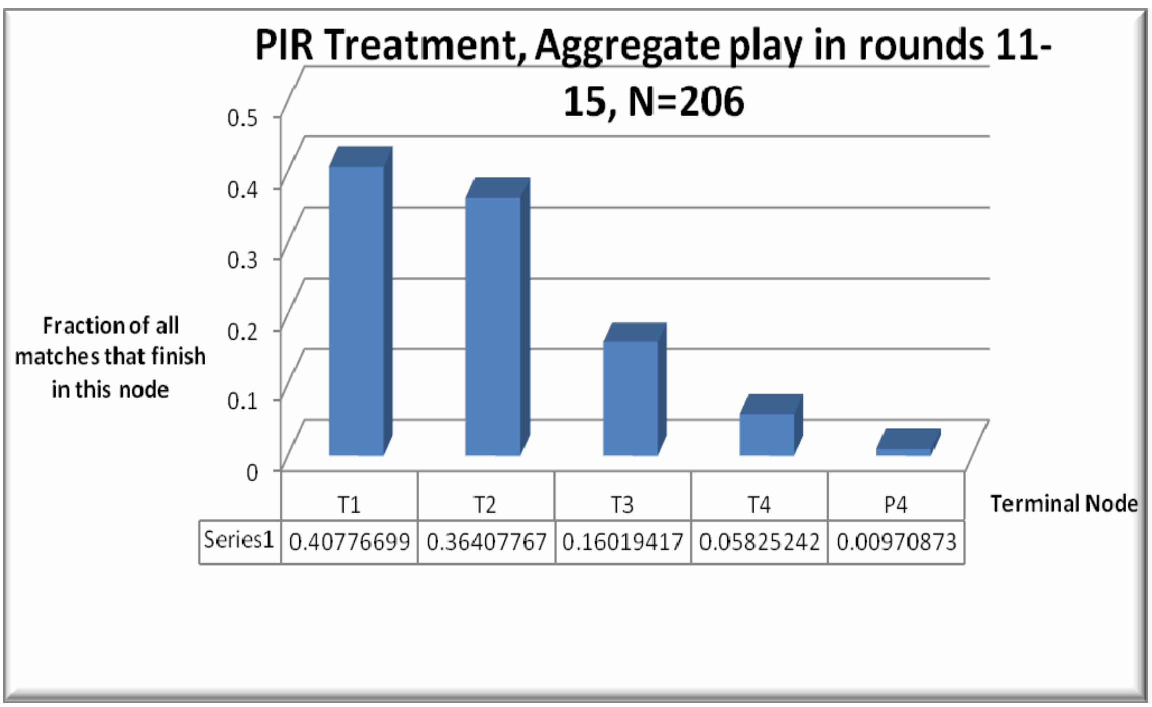

Figure 2.8 Fractions of Rounds in each Terminal Node, Treatment PIR, Rounds 11-15

We anticipate that in the modified payoff treatments, aggregate information will increase payoffs, rather than decrease them, and we shall explain the theoretical reasons for this. In a setting without information release, YELLOW players who pass in the last decision node sacrifice less money than in the game with the original payoffs, and we expect that more YELLOW subjects will pass in the last decision node. The purely selfish incentive of a GREEN subject then is to pass more in all his nodes, since it is more likely that he will end up with 9 dollars. Anticipating this, YELLOW subjects should also pass more in their first move. This should push the distribution in the opposite direction than the Nash equilibrium prediction. So, we expect that, in the absence of aggregate information, the new payoffs will lead to more passing behavior in general.

Now, our results in treatments NIR, FIR and PIR showed that theories of "conditional cooperation" explain subjects' behavior well. When aggregate information is released, we expect the psychological "reciprocity incentive" to push the data in the same direction as the money-making incentive. This is because now subjects observe a larger fraction of their opponents "trusting" them in early nodes. If subjects have a "threshold" level of opponents' aggregate behavior, based on which they positively or negatively reciprocate, this threshold is likely to be met after the change in payoffs.[51] If it is the case, the net effect of reciprocity, compared to the setting with no information, shall be in the direction of increasing payoffs. Moreover, people will be expected to pass more, so they

[51]It is unlikely that agents shall fully adjust their expectations to the different structure of payoffs.

may be inclined to meet these expectations. Hence we predict that, with modified payoffs, the effect of information release will be positive for society, rather that negative.

Hypothesis 4 **:** Information revelation leads to higher social payoffs in the modified payoff treatments. We test whether average per match payoffs in rounds $11-15$ are the same in treatments NIR-M and FIR-M.

Hypothesis 5: The conditional "take" probability in the last decision node is lower in the NIR-M treatment than in the NIR treatment.

Hypothesis 6 **:** The modification in payoffs leads to higher total payoffs in NIR-M relative to NIR. We test whether average per match payoffs in rounds $11-15$ are the same in treatments NIR-M and NIR.

2.7.1 Treatments NIR-M and FIR-M: Results

Information revelation really increased payoffs in the modified payoff setting, although not significantly. The average per-match payoff in rounds $11-15$ of FIR-M and NIR-M is 3.37 and 2.92 respectively. The one-tailed p-value of the t-test is 0.061, hence we cannot reject the hypothesis that payoffs are the same. However, hypothesis 4 gains some support from these results. In treatment FIR-M many subjects achieved very high payoffs, reaching the last or the penultimate terminal node. A significantly higher fraction of matches in rounds $1-15$ ended in the last terminal node in treatment FIR-M compared to NIR-M. Moreover, a very low fraction of people play the Nash equilibrium strategy in NIR-M and a somewhat higher fraction in FIR-M. Apparently, full information revelation in the centipede game does not always imply strong convergence to the Nash equilibrium terminal node. On average, information revelation tends to increase social welfare when payoffs are modified.

Figures $2.9-2.12$ display the aggregate distributions of matches that end in each terminal node for treatments NIR-M and FIR-M, both for rounds $1-15$ and for rounds $11-15$. The distribution of play in late rounds of NIR-M is very different from the distribution of NIR, and this result is strongly statistically significant. A very low fraction of total matches ends in the first terminal node in treatment NIR-M, even in late rounds, and the hypothesis of equality of this fraction with the equilibrium fraction in NIR is overwhelmingly rejected. Surprisingly, the conditional "take" probability in the last decision node in treatment NIR-M is higher than in treatment NIR (84% vs. 78%) but the difference is not statistically significant. Thus, hypothesis 5 is rejected.

It seems that subjects expect YELLOW people to pass more frequently in the last decision node in treatment NIR-M and this expectation is not met. Additionally, the conditional "take" probability in the last decision node in treatment FIR-M is only 69% and this is significantly lower than 84%. Hence, aggregate information has increased the willingness of subjects to pass in the last decision node in the treatment with modified payoffs. Of course, part of this seemingly altruistic behavior could be due to signaling. Moreover, average payoffs in treatment NIR-M are high and hypothesis 6 is supported by the data. Average payoffs per match in rounds $11-15$ are 2.13 for NIR and 2.92 for NIR-M and this difference is statistically significant (t-test, one-tailed, p-value 0.002).

It is also worth emphasizing that the distribution over terminal nodes in session FIR2-M is very different from the distribution in sessions FIR1-M and FIR3-M

(Appendix1). This difference is statistically significant with p-value less than 0.0001. The reason for this difference is that information revelation introduces path dependence. If subjects start by trusting each other and "pass" frequently, information revelation combined with reciprocity is likely to increase this tendency. If, on the other hand, subjects do not pass much in the early rounds, then pessimism and reciprocity will lead to convergence to the Nash equilibrium outcome. This path dependence has also played a role in the difference in the results of sessions PIR1 and PIR2, PIR3.

The change in the effects of information revelation caused by the moderate modification in payoffs is remarkable. Recall that the average per match payoff in the late rounds of treatment FIR was equal to 1.4. In treatment FIR-M, which differs from treatment FIR in a minor way, average payoff is 3.37, more than double, and of course this difference is statistically significant. More importantly, full information reduces total payoffs significantly in the treatments with the initial payoff function and somewhat increases payoffs in the treatments with the modified payoff function. Therefore, we conclude that the effect of information release is very sensitive to minor changes in payoffs.

2.8 Discussion

In the "Information Treatments", a particular subject's action in a specific round affects the aggregate information released in the subsequent round. Hence, information revelation introduces repeated game aspects in treatments FIR, PIR, FIR-M.

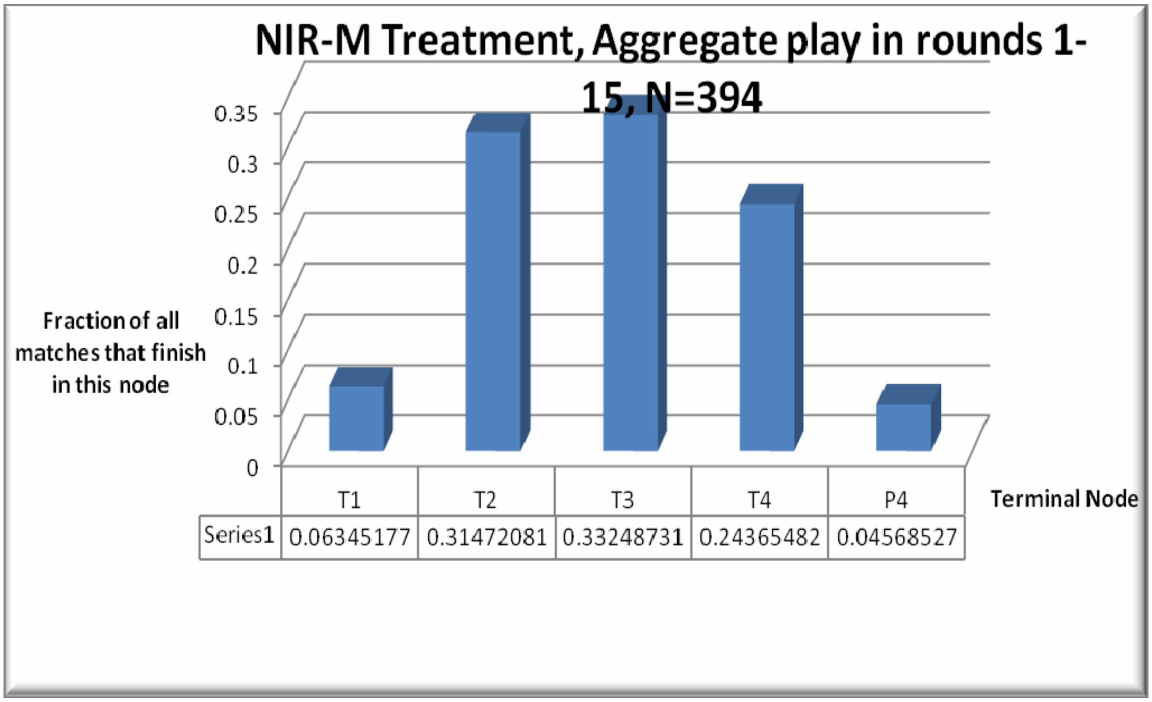

Figure 2.9 Fractions of Rounds in each Terminal Node, Treatment NIR-M, Rounds 1-15

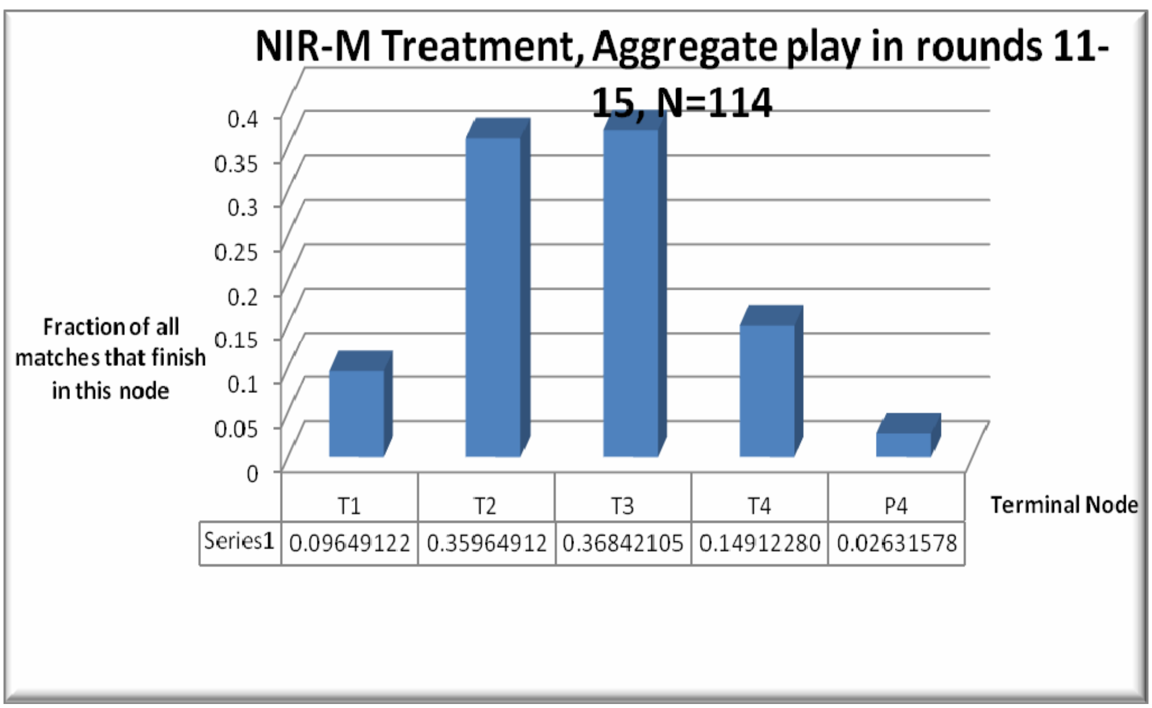

Figure 2.10 Fractions of Rounds in each Terminal Node, Treatment NIR-M, Rounds 11-15

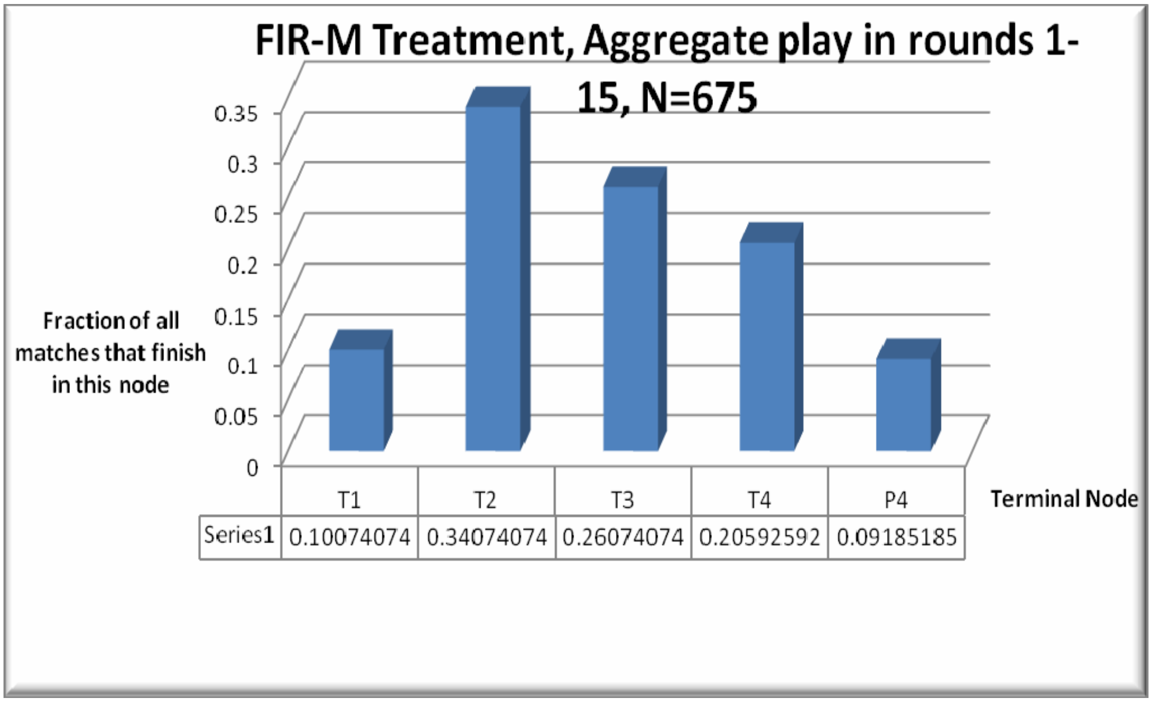

Figure 2.11 Fractions of Rounds in each Terminal Node, Treatment FIR-M, Rounds 1-15

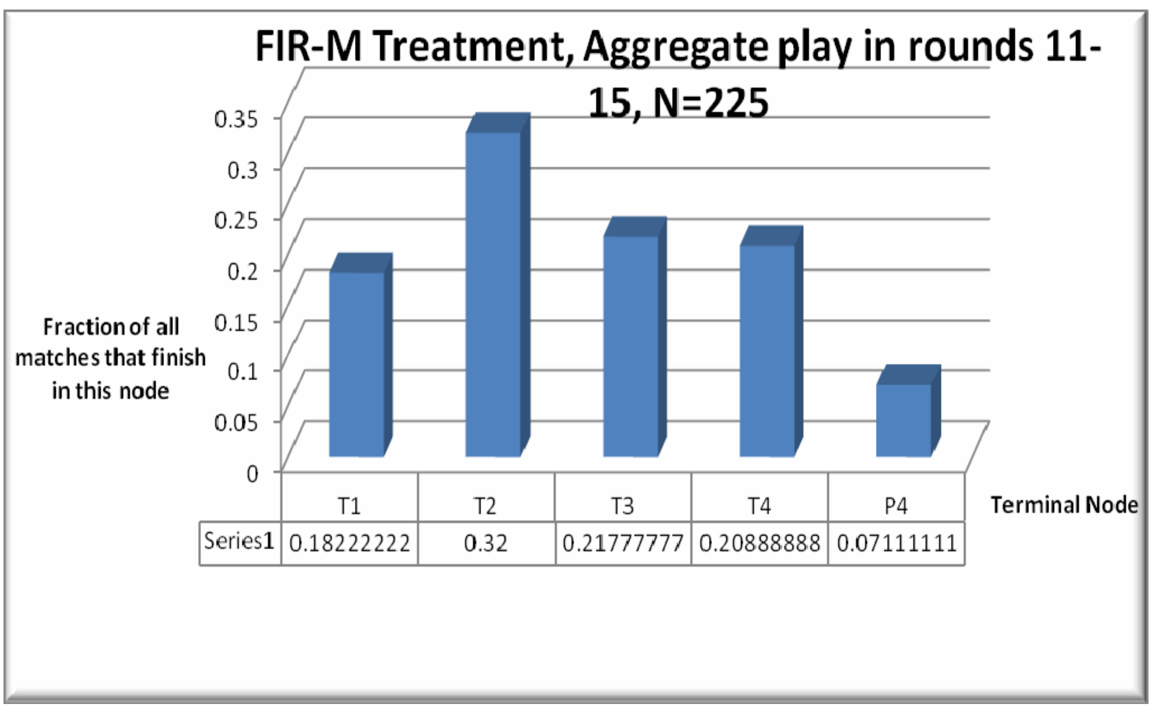

Figure 2.12 Fractions of Rounds in each Terminal Node, Treatment FIR-M, Rounds 11-15

Participants could sacrifice payoffs in the current round in order to induce more cooperative behavior later, especially if they are likely to be the only ones reaching a particular node in the current round.[52] This fact makes the low level of cooperation in treatments FIR, PIR all the more surprising. In treatments FIR and PIR average payoffs are so low that is it tough to imagine that subjects signaled and induced passing behavior. We therefore believe that the very few instances of passing in late nodes in PIR and especially in FIR, provide strong evidence that signaling was not an important factor.

However, there seem to be a few instances of signaling behavior. Session FIR 2 (Figure 2.13) is particularly interesting. Within seven rounds, play has already shown strong signs of convergence, and the fraction of Nash equilibrium play has reached 80%. However, at this point, some subjects may have realized that signaling is possible and passed in late nodes, possibly as a means to induce more passing in the future. Behavior changed for a few rounds and it returned to high frequencies of equilibrium play. Even following the successful signaling effort of a few subjects, no other signaling efforts were made. Hence, even after seeing its possible benefits, subjects failed to use signaling extensively. Moreover, although we have no reason to expect that it was easier for subjects to understand the importance of signaling in the sessions with modified payoffs, we cannot rule out the possibility that signaling may have played an important role in the evolution of play in treatment FIR-M.

[52] In the sessions where play converged to the Nash equilibrium outcome, some nodes were never reached or very seldom reached. This implies that two subjects could pass in late nodes, in their match, and almost single-handedly determine the fractions of play to be revealed in the next round, for these nodes. Other subjects may not realize that these data are due to a single decision, and this may induce more passing in general and higher payoffs in the long run.

It may also be useful to look at last node-behavior in all sessions. Figure 2.14 shows the "take" probabilities, conditional on that the last decision node was reached, in all the "information" and "non-information" sessions. The differences are more important than they seem. We should point out once more that the threshold value of this probability, bellow which it is profitable for a GREEN subject to pass in the third decision node is 0.857. In almost all non-information sessions the "take" probability is smaller than this threshold value, which implies that a selfish player who knows this should pass at all nodes except the last one. In all "information" sessions with the initial payoffs, the "take" probability in the last decision node is larger than 0.857, so one would expect play eventually to unfold to the equilibrium outcome. Hence, the observed differences in these probabilities are very important. With modified payoffs, the two sessions where the threshold was not exceeded were the ones that achieved high frequencies of reaching late nodes and high payoffs. This supports the important role we attribute to "last decision node behavior" in explaining our results.

The fact that information revelation leads to convergence to the Nash equilibrium outcome in our "initial payoff treatments" is important, because it partly explains the paradox in the results of MP. As we have seen, there have been many efforts to increase the low frequency of equilibrium play in early experiments of the centipede game. Researchers have performed experiments where they modified various parameters, such as the number of players, the size of the payoffs, the structure of the payoffs, even the discrete timing of the game, to check if the divergence from equilibrium play is robust to all these changes. Here we show that in exactly the same game, with only different information feedback, equilibrium play is much more common. Even without information release, our subjects reach the Nash equilibrium outcome much more frequently.

At the same time, we show that aggregate information by no means guarantees convergence to Nash equilibrium outcomes under all circumstances. Our results indicate that aggregate information can have very different effects regarding convergence to Nash equilibrium, even in very similar games. We could tentatively argue that aggregate information pushes closer to Nash equilibrium when it reinforces players' selfish motives. For example, information which shows that people act selfishly intensifies this behavioral tendency even further and induces more convergence to Nash outcomes. On the other hand, information that shows the opposite is more likely to lead far from the Nash equilibrium outcome, rather than causing convergence to it.

Furthermore, the data support the idea that in environments where the long-run state of the economy is likely to be described as a heterogeneous self-confirming equilibrium, manipulation of aggregate behavior is possible by means of selective aggregate information revelation. This type of manipulation can only be effective if the results of aggregate information release are not easily predictable, otherwise the public may easily second-guess the intentions of the information revealer. In chapter one we showed that selective revelation of the aggregate distributions of actions can push the dynamic system to specific long-run states, which may be preferable for the aggregate information possessor. We believe that there is more scope to the experimental examination of this idea. However, it should be noted this study was not a direct test of our theoretical model and the results are only suggestive. Moreover, social preferences seem to have played an important role in subjects' behavior and to have strongly affected our experimental results. This effect is not captured in the theoretical model, which assumes standard preferences.

Finally, what do our results have to say with respect to the major practical question: is aggregate information good for society? Our experimental results suggest that it depends on the nature of the revealed data and the type of social preferences they are likely to bring into play. In a trust game such as the one we are examining, the major issue is whether aggregate information increases trust or not. We have seen that subjects seem to have preferences driven by "conditional moral motivation". Hence, any data, which show that people exhibit "enough" trusting behavior, should be revealed, because it seems that aggregate information reinforces existing trends in behavior. We have also shown that aggregate information release can have opposite effects in different circumstances which seem very similar to each other. This means that aggregate information release is a risky business. At the same time, aggregate information has increased the variance of achieved payoffs across sessions even in treatments where it increased average payoffs. This may decrease the desirability of aggregate information release even if, on average, it seems to benefit society.

Our results offer some support for policies that conceal aggregate information when this information is likely to exacerbate existing detrimental or antisocial behaviors. An example of such a policy is selective information release of aggregate behavior in financial markets, which tries to increase optimism and to prevent panic. Our results also indicate that overemphasizing corruption or the cynical attitudes of officials at the wrong moment may do more harm than good for a society. Finally, it is worth emphasizing that economic effects have of course to be taken into account, but they are not the only criterion by which to judge the desirability of aggregate information. Values such as transparency may be respected for their own merit, regardless of their economic consequences.

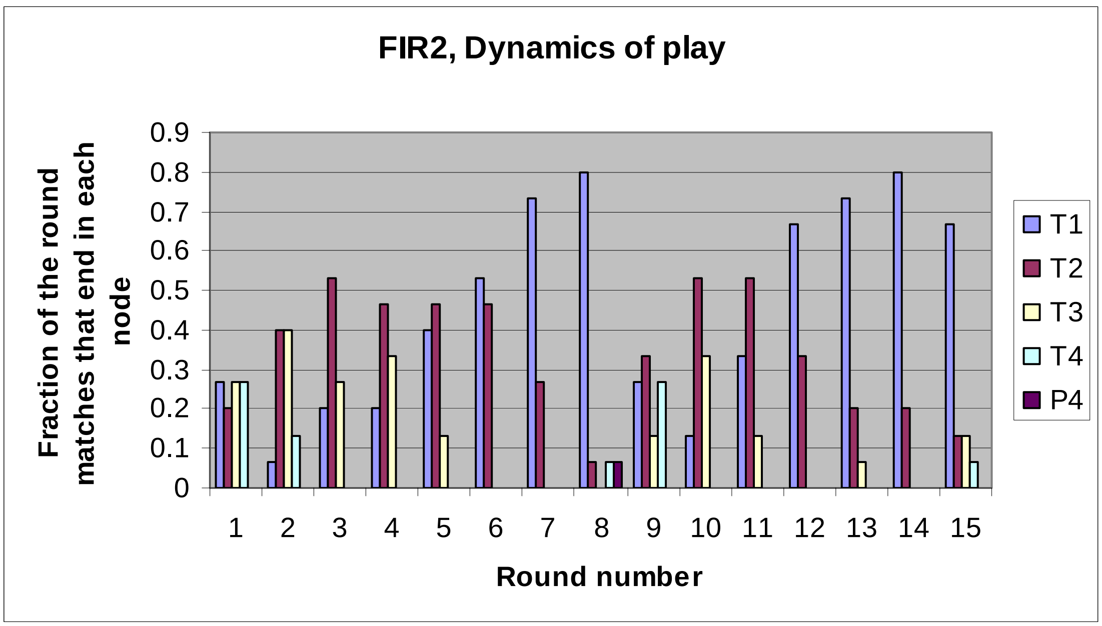

Figure 2.13 An Example of Dynamic Evolution of Play

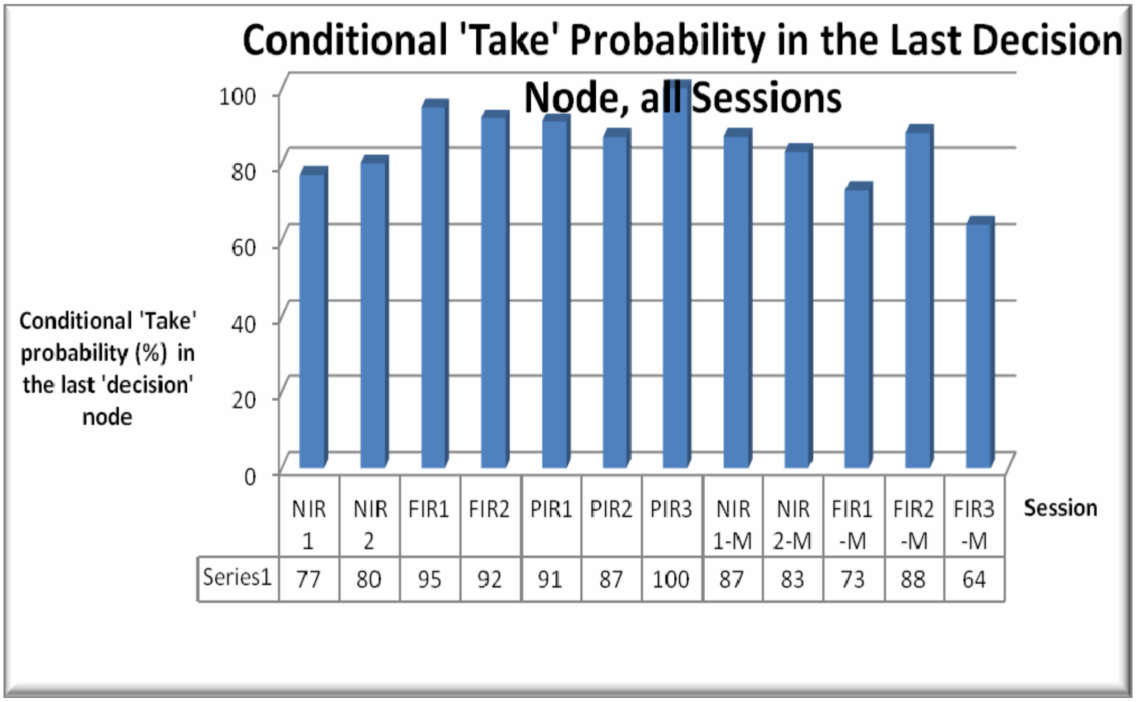

Figure 2.14 Conditional "Take" Probabilities

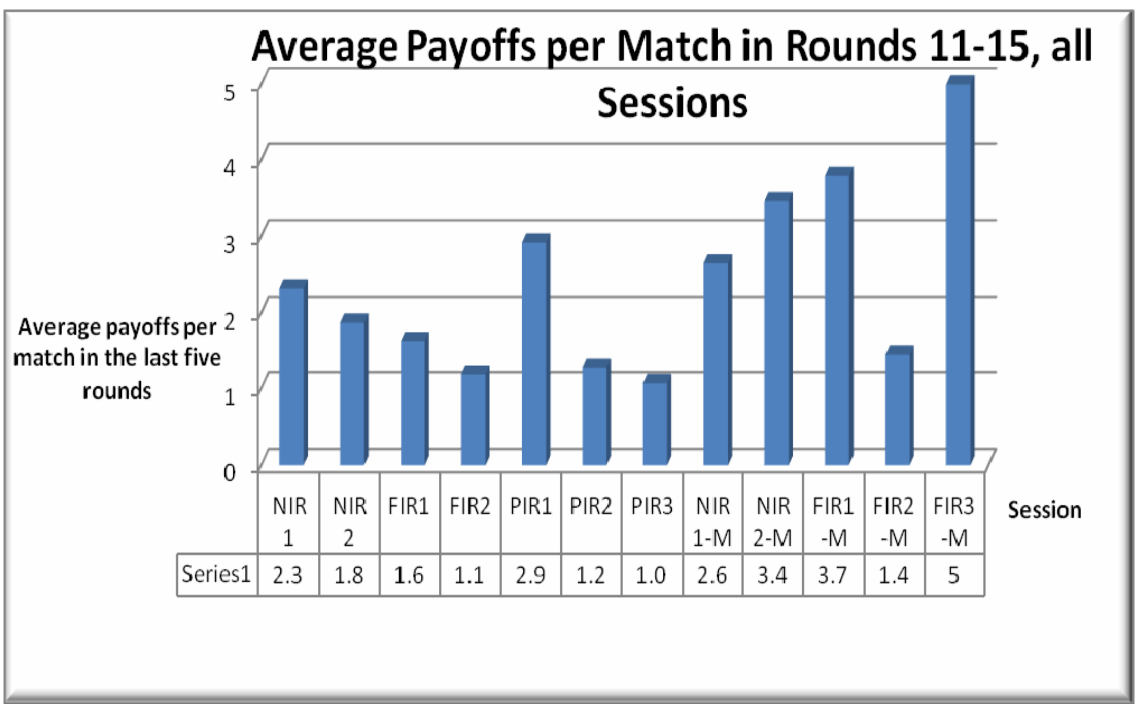

Figure 2.15 Average Payoffs per Match

2.9 Conclusions

We conducted an experimental investigation of the centipede game where subjects received information about the aggregate fractions of each population that chose each action. Using payoffs similar to MP, we found that, contrary to the predictions of FL, both full and partial information release causes convergence to the Nash equilibrium outcome and low payoffs. With slightly modified payoff functions, full aggregate information increased subjects' average earnings. This provides evidence that the optimal information release scheme in trust games is to reveal optimistic information selectively, because aggregate information does not guarantee convergence to Nash equilibrium or higher social payoffs in all circumstances. However, our results also showed that it is generally difficult to predict a priori how play will be affected by information revelation, and that this type of period-by-period information release may be sensitive to the uncertainty of initial play. We also found evidence that agents' behavior is driven by conditional cooperation because our results do not seem compatible with other types of preferences.

Further study can improve our understanding. Future experiments should be able to illuminate many aspects of play. First of all, an explicitly selective information revelation scheme could be used. For example, the fractions of play could be revealed only when they exceed a certain threshold level. Experiments using this method could examine the degree to which subjects understand the fact that they are exposed to selective information, and their response to such a realization. Moreover, there are reasons to expect that revealing aggregate data about more than one round could lead to different results, because time-dependence would decrease and profitable signaling would be impossible. Furthermore, our rich data set can be used for quantitatively testing specific theories. In particular, it would be interesting to examine how individuals respond to aggregate information, estimating a model that assigns subjects to "types", based on the nature of their response to aggregate information, as in Frey and Meier (2004).

Appendix 1. Descriptive Data for all Sessions

Results from Session NIR 1

	Number of matches that finished in the particular node				
	T1	T2	T3	T4	P4
Sum of all rounds	52	90	53	23	7
Sum of last 5	22	29	14	8	2

Fraction of all games in rounds 1-15 ending in each node

T1	T2	T3	T4	P4
0.231	0.4	0.236	0.102	0.031

Fraction of all games in rounds 11-15 ending in each node

T1	T2	T3	T4	P4
0.293	0.387	0.187	0.107	0.027

Rounds 6-10

T1	T2	T3	T4	P4
0.293	0.453	0.133	0.093	0.027

Implied TAKE probability given a node has been reached

	T1	T2	T3	T4
Rounds 1-15	0.231	0.52	0.639	0.767
Rounds 11-15	0.293	0.547	0.583	0.8

	Rounds 1-15	Rounds 11-15
Average payoffs	18.6	5.8

Results from Session NIR 2

Number of matches that finished in the particular node					
	T1	**T2**	**T3**	**T4**	**P4**
Sum of all rounds	60	68	43	20	5
Sum of Last 5	26	27	13	3	1

Fraction of all games in rounds 1-14 ending in each node				
T1	**T2**	**T3**	**T4**	**P4**
0.306122449	0.346939	0.219388	0.102041	0.02551
Fraction of all games in rounds 10-14 ending in each node				
T1	**T2**	**T3**	**T4**	**P4**
0.371428571	0.3857	0.1857	0.0428	0.0142
Rounds 6-10				
T1	**T2**	**T3**	**T4**	**P4**
0.385	0.371	0.1857	0.0428	0.0142

Implied TAKE Probability given a node has been reached				
	T1	**T2**	**T3**	**T4**
Rounds 1-14	0.306122	0.5	0.632353	0.8
Rounds 10-14	0.371429	0.613636	0.764706	0.75
	Rounds 1-15	**Rounds 11-15**		
Average payoffs	16.4	4.6		

Results from MP, 4-move, Normal Payoffs, Rounds $6-10$, $N=136$

	Number of matches that finished in the particular node				
	T1	**T2**	**T3**	**T4**	**P4**
No. of Matches	11	56	52	14	3
Fraction	0.081	0.412	0.382	0.103	0.022

Results from NIR, Rounds $6-10$, $N=145$

	Number of matches that finished in the particular node				
	T1	**T2**	**T3**	**T4**	**P4**
No. of Matches	49	60	23	10	3
Fraction	0.337	0.413	0.158	0.068	0.02

Results from Session FIR 1

	Number of matches that finished in each node				
	T1	**T2**	**T3**	**T4**	**P4**
Sum of all rounds	34	76	76	37	2
Sum of last 5	27	32	14	2	0

Fraction of all games in rounds 1-15 ending in each node

T1	**T2**	**T3**	**T4**	**P4**
0.151	0.338	0.338	0.165	0.009

Fraction of all games in rounds 11-15 ending in each node

T1	**T2**	**T3**	**T4**	**P4**
0.36	0.427	0.187	0.027	0

Implied TAKE probability given a node has been reached

	T1	**T2**	**T3**	**T4**
Rounds 1-15	0.151	0.398	0.660	0.949
Rounds 11-15	0.36	0.667	0.875	1

	Rounds 1-15	Rounds 11-15
Average payoffs	20.55	4.075

Results from session FIR 2

Number of matches that finish in each node					
	T1	**T2**	**T3**	**T4**	**P4**
Sum of all rounds	102	77	33	12	1
Sum of last 5	48	21	5	1	0

Fraction of games in rounds 1-15 ending in each node

T1	T2	T3	T4	P4
0.453	0.342	0.147	0.053	0.0044

Fraction of games in rounds 11-15 ending in each node

T1	T2	T3	T4	P4
0.64	0.28	0.067	0.013	0

Implied TAKE probability given a node has been reached

	T1	T2	T3	T4
Rounds 1-15	0.453	0.626	0.72	0.923
Rounds 11-15	0.64	0.778	0.833	1

	Rounds 1-15	Rounds 11-15
Average payoffs	12.6	2.95

Results from Session PIR1

Number of matches that finish in each node					
	T1	**T2**	**T3**	**T4**	**P4**
Sum of all rounds	15	86	79	41	4
Sum of last 5	6	31	24	12	2

Fraction of all games in rounds 1-15 ending in each node				
T1	**T2**	**T3**	**T4**	**P4**
0.067	0.382	0.351	0.1822	0.018
Fraction of all games in rounds 11-15 ending in each node				
T1	**T2**	**T3**	**T4**	**P4**
0.08	0.413	0.32	0.16	0.027
Implied TAKE probability given a node has been reached				
	T1	**T2**	**T3**	**T4**
Rounds 1-15	0.067	0.41	0.637	0.91
Rounds 11-15	0.08	0.45	0.632	0.858
	Rounds 1-15	**Rounds 11-15**		
Average payoffs	22.5	7.3		

Results from Session PIR2

	Number of matches that finish in the particular node				
	T1	**T2**	**T3**	**T4**	**P4**
SUM of all rounds	67	78	43	7	1
Sum of last 5	37	25	8	0	0
Sum of 9 first	30	53	35	7	1

Fraction of all games in rounds 1-14 ending in each node				
T1	**T2**	**T3**	**T4**	**P4**
0.341	0.398	0.22	0.036	0.005
Fraction of all games in rounds 11-14 ending in each node				
T1	**T2**	**T3**	**T4**	**P4**
0.529	0.358	0.114285714	0	0

Implied TAKE probability given a node has been reached				
	T1	**T2**	**T3**	**T4**
Rounds 1-14	0.341	0.605	0.843	0.875
Rounds 10-14	0.529	0.758	1	NA

	Rounds 1-15	**Rounds 11-15**
Average payoffs	12.7	3.18

Results from Session PIR 3

	Number of matches that finish in each node				
	T1	**T2**	**T3**	**T4**	**P4**
Sum of all rounds	93	84	41	7	0
Sum of last five	49	23	3	0	0
SUM OF FIRST 10	44	61	38	7	0

Fraction of all games in rounds 1-15 ending in each node

T1	**T2**	**T3**	**T4**	**P4**
0.413	0.373	0.182	0.031	0

Fraction of all games in rounds 11-15 ending in each node

T1	**T2**	**T3**	**T4**	**P4**
0.653	0.306	0.04	0	0

Implied TAKE probability given a node has been reached

	T1	**T2**	**T3**	**T4**
Rounds 1-15	0.4133	0.636	0.854	1
Rounds 11-15	0.653	0.8846	1	NA

	Rounds 1-15	**Rounds 11-15**
Average payoffs	12.1	2.67

Results from Session NIR 1-M

	Number of matches that finished in each node				
	T1	**T2**	**T3**	**T4**	**P4**
Sum of all rounds	24	83	73	39	6
Sum of last 5	11	29	25	8	2

Fraction of all games in rounds 1-15 ending in each node

T1	**T2**	**T3**	**T4**	**P4**
0.107	0.369	0.325	0.173	0.027

Fraction of all games in rounds 11-15 ending in each node

T1	**T2**	**T3**	**T4**	**P4**
0.146	0.387	0.333	0.107	0.027

Implied TAKE probability given a node has been reached

	T1	**T2**	**T3**	**T4**
Rounds 1-15	0.107	0.412	0.618	0.867
Rounds 11-15	0.147	0.453	0.714	0.8

	Rounds 1-15	**Rounds 11-15**
Average payoffs	22.3	6.6

Results from Session NIR 2-M

	Number of matches that finished in each node				
	T1	**T2**	**T3**	**T4**	**P4**
Sum of all rounds	1	41	58	57	12
Sum of last 5	0	18	31	15	1

Fraction of all games in rounds 1-15 ending in each node

T1	**T2**	**T3**	**T4**	**P4**
0.006	0.242	0.343	0.337	0.007

Fraction of all games in rounds 11-15 ending in each node

T1	**T2**	**T3**	**T4**	**P4**
0	0.276	0.476	0.23	0.15

Implied TAKE probability given a node has been reached

	T1	**T2**	**T3**	**T4**
Rounds 1-15	0.006	0.244	0.457	0.826
Rounds 11-15	0	0.277	0.659	0.937

	Rounds 1-15	**Rounds 11-15**
Average payoffs	27.8	8.5

Results from Session FIR 1-M

	Number of matches that finished in each node				
	T1	**T2**	**T3**	**T4**	**P4**
Sum of all rounds	5	91	56	53	20
Sum of last 5	5	31	14	18	7

Fraction of all games in rounds 1-15 ending in each node				
T1	**T2**	**T3**	**T4**	**P4**
0.022	0.404	0.249	0.235	0.089
Fraction of all games in rounds 11-15 ending in each node				
T1	**T2**	**T3**	**T4**	**P4**
0.067	0.413	0.187	0.24	0.093

	Implied TAKE probability given a node has been reached			
	T1	**T2**	**T3**	**T4**
Rounds 1-15	0.022	0.413	0.434	0.726
Rounds 11-15	0.067	0.442	0.359	0.72

	Rounds 1-15	**Rounds 11-15**
Average payoffs	29	9.4

Results from Session FIR 2-M

	Number of matches that finished in each node				
	T1	**T2**	**T3**	**T4**	**P4**
Sum of all rounds	61	109	38	15	2
Sum of last 5	36	30	6	3	0

Fraction of all games in rounds 1-15 ending in each node				
T1	**T2**	**T3**	**T4**	**P4**
0.271	0.484	0.168	0.067	0.009
Fraction of all games in rounds 11-15 ending in each node				
T1	**T2**	**T3**	**T4**	**P4**
0.48	0.4	0.08	0.04	0

	Implied TAKE probability given a node has been reached			
	T1	**T2**	**T3**	**T4**
Rounds 1-15	0.271	0.664	0.69	0.882
Rounds 11-15	0.48	0.769	0.667	1

	Rounds 1-15	**Rounds 11-15**
Average payoffs	14.7	3.6

Results from Session FIR 3-M

	Number of matches that finished in each node				
	T1	**T2**	**T3**	**T4**	**P4**
Sum of all rounds	2	30	82	71	40
Sum of last 5	0	11	29	26	9

Fraction of all games in rounds 1-15 ending in each node

T1	**T2**	**T3**	**T4**	**P4**
0.009	0.133	0.364	0.315	0.178

Fraction of all games in rounds 11-15 ending in each node

T1	**T2**	**T3**	**T4**	**P4**
0	0.147	0.387	0.347	0.12

Implied TAKE probability given a node has been reached

	T1	**T2**	**T3**	**T4**
Rounds 1-15	0.009	0.134	0.425	0.639
Rounds 11-15	0	0.147	0.453	0.742

	Rounds 1-15	**Rounds 11-15**
Average payoffs	40	12.25

Appendix 2. Instructions for Treatment FIR

INSTRUCTIONS

Introduction.

Welcome to CASSEL. The policy in this lab is never to deceive participants. This is an experiment in group decision making, and you will be paid for your participation in cash, at the end of the experiment. Different participants may earn different amounts. What you earn depends partly on your decisions, partly on the decisions of others, and partly on chance. Please turn off all pagers and cell phones now.

The entire experiment will take place through computer terminals, and all interaction between you will take place through the computers. It is important that you do not talk, or in any way try to communicate with others during the experiment.

We will start with a brief instruction period. During the instruction period you will be given a description of the main features of the experiment and will be shown how to use the computers. If you have any questions during the instruction period, please raise your hand and your question will be answered so anyone can hear. If you have any difficulties after the experiment has begun, please raise your hand and an experimenter will come and assist you.

You will be divided into two groups, each containing ___ people. The groups will be labeled the GREEN and the YELLOW group. The computer you are using will assign you to one of the two groups. If you are assigned to be GREEN you will be GREEN throughout the experiment. If you are assigned to be YELLOW you will be YELLOW throughout the experiment.

A Decision Problem

In this experiment, you will be participating in the following interaction, for real money.

In each round you will be matched with a person of the other color. During each move of a particular round, either you or the person you are matched with makes an action. The payoffs for you, and for the person you are matched with, depend on the moves you both make.

In pages 6 and 7 of the instructions you see an illustration of a specific round based on the experiment screen.

There are two piles of money: a Large Pile and a Small Pile. At the beginning of the round, the Large Pile has 60 cents and the Small Pile has 15 cents.

GREEN has the first move and can either pass or take the pile. If GREEN chooses “Take”, GREEN gets the Large Pile of 60 cents, YELLOW gets the Small Pile of 15 cents, and the round is over. If GREEN chooses “Pass”, both piles double and it is YELLOW’s turn.

The Large Pile now contains 1.20 dollars and the Small Pile 30 cents. Now YELLOW can take or pass the pile. If YELLOW takes, YELLOW ends up with the Large Pile of 1.20 dollars and GREEN gets the Small Pile of 30 cents and the round is over. If YELLOW passes, both piles double and it is GREEN’s turn again.

The Large Pile now contains 2.40 dollars and the Small Pile 60 cents. GREEN can again take or pass the pile. If GREEN takes, GREEN ends up with the Large Pile of 2.40 dollars and YELLOW ends up with the Small Pile of 60 cents and the round is over. If GREEN passes, both piles double and it is YELLOW’s turn again.

The Large Pile now contains 4.80 dollars and the Small Pile 1.20 dollars. This is the last move, and it is YELLOW’s second choice. If YELLOW takes the pile, YELLOW ends up with the Large Pile of 4.80 dollars and GREEN gets the Small Pile of 1.20 dollars and the round is over. If YELLOW passes, then the piles double again. GREEN then gets the

Large Pile of 9.60 dollars and YELLOW gets the Small Pile of 2.40 dollars. Note that this is not an actual move, since GREEN has only one choice.

After the end of the first round, you will have the opportunity to get information about what all the YELLOW people and all the GREEN people chose in the previous round. In particular, for each of the moves, you will see the fraction of the people who chose “Take” and the fraction that chose “Pass” in the previous round. For example, during the third round, you will see information that refers to the behavior of participants in the second round.

In the first box, the GREEN people move. The numbers under the word “History” represent the fractions of GREEN people who chose “Take” and the fraction of the GREEN people who chose “Pass”, in this move, in the previous round. Similarly, in the second box, the YELLOW people move. In the second box, the numbers under the word “History” represent the fractions of the YELLOW people who chose “Take” and the fraction of the YELLOW people who chose “Pass”, in this particular move, in the previous round.

Note that not all the YELLOW people need have moved in this box in the previous round. Remember that all boxes, except the first one, are reached only if the other player chooses “Pass” in the previous box. The numbers under “History” have the same meaning in the other boxes. If a box does not have “History”, this implies that this box was never reached in the previous round.

The experiment consists of ____ rounds. In each round you will interact with a person of the different color. So this person will be GREEN if you are YELLOW and YELLOW if you are GREEN. You will not be matched with the same person twice, as there are _____ people of the other color. So you will be matched with each person of the other color exactly once.

Practice Session.

We will now start the instruction session. During the instruction session, we will teach you how to use the computers by going through three practice rounds. During the instruction period please do not hit any key unless you are instructed to. You will not be paid for the practice rounds. Please wait until we set up the experiment.

Please double click on the small red icon labeled “MC”. When the computer prompts for your name, please type the number of the computer you are in, for example if you are at computer 14, type “SSEL 14”. Then, please hit the “SUBMIT” key.

Now you should all have a window saying: “Please Wait. Connecting to Server”. Please do not close any windows.

Now all of you should be able to see the experiment screen. The experiment screen should display five boxes. Remember that the last box does not describe a real move since GREEN can only choose “Take”. You see that the first match has begun. The box with the red color represents the current move, in which, one of the two participants has to make a choice. If it is your turn to move, you are given a description of the choices available to you.

If you are told in the first box that this is your move, and you have the choice menu, you are a GREEN participant. If you are told to wait for your partner to make his/her decision, you are a YELLOW participant. You will have the same color throughout the experiment. Please record your color and computer number in your record sheet. You need to record your computer number since you will be paid according to this number.

We will now start the first practice round. Will all the GREEN participants please choose PASS from your menu now?

GREEN participants now receive a message that they have passed, and now the other person (YELLOW) will get the opportunity to take or pass the pile. YELLOW participants now receive a message that the person they are matched with (GREEN) has passed the pile, and now they will have the move. Please do not forget to click “OK” on your information icons each time.

Since GREEN chose PASS, the second box now has the red color, and the YELLOW person now has the choice menu, indicating that it is YELLOW'S move. The GREEN participants are told that it is the other person's turn to choose. Notice that there is now a large pile of 1.2 dollars and a small pile of 30 cents.

Will all the YELLOW participants please choose TAKE from you menu now?

Since YELLOW chose TAKE, the round has ended. A message informs that you or the other participant, depending on your color, has taken the pile, and tells you your payoffs. Please record your payoffs to the record sheet provided. You must do so after every round in order to double-check your payoffs are correct.

You are not being paid for the practice session, but if this was the real experiment, then the payoffs you have recorded would be money you have earned from the first round, and you would be paid this amount for that round at the end of the experiment. The total you earn over all the _____ real rounds, plus your guaranteed show up fee of five dollars, is what you will be paid for your participation in the experiment.

We will now proceed to the second practice round. You now see that you have been matched with a new person of the opposite color and that the second round has begun. Does everyone see this?

The rules for the second round are exactly like the first, but now you can observe the way participants played in the first practice round. The numbers at the lower part of the boxes, under the word “History”, represent the fractions of “Take” and “Pass” decisions of participant the previous match. In the first box, you are being informed that that all the GREEN persons have chosen “Pass” in their first decision in the previous round.

Similarly, in the second box, which corresponds to the second move of the round, but only to the first decision of the YELLOW participants, you are informed that all the YELLOW people who moved chose “Take” in their first decision. The other boxes do not have numbers because there were no decisions at all to be revealed: no GREEN or YELLOW participants reached their second move. Remember that the fractions under “History” refer only to the preceding round, not all the previous rounds completed.

Now you are free to choose whatever you want in the next two practice rounds. Please stop after you have completed the third practice round. Please record your payoffs to the record sheet provided, but remember you are not paid for the practice rounds. Please remember to record your payoffs after each real round.

This concludes the practice session. In the actual experiment there will be ____ rounds instead of three, and of course, it will be up to you to make your own decisions. You will not see any history in the first round. Remember that you will meet each person of the other color exactly once. At the end of round ____, the experiment ends and we will pay each of you privately in cash, the total amount you have accumulated during all real rounds, plus your guaranteed five dollar participation fee. No other person will be told how much cash you earned in the experiment. You need not tell any other participants how much you earned.

We will now begin with the actual experiment. If there are any problems from this point on, please raise your hand and an experimenter will come and assist you.

Chapter 3. Campaign Contributions as a Commitment Device

3. 1 Introduction

We propose a new channel through which institutions that allow for private campaign contributions[53] may affect economic efficiency. Contributions may serve as a commitment device that helps keep control over the expectations of the private sector about economic policy, especially with respect to important macroeconomic indices. The basic argument of this paper is that society as a whole may benefit from this institution if it helps solve dynamic inconsistency problems and induce investments. If the investment decisions of private firms determine economic growth and employment, as is the case in most capitalist economies, voters have a common interest in making their governments commit to policies that encourage private investments. However, governing parties may, in general, renege on promises for economic stability and choose excessively leftist policies if direct policy commitment is impossible. Campaign contributions or media control by firm interests tend to restraint the scope of this opportunism and provide a commitment device.[54] This is achieved if the private sector in the political game gets to

[53] Throughout this paper, "campaign contributions" will be understood either as monetary amounts given to the candidates or parties and used for campaigning, or as contributions "in kind", such as favorable media influence in favor of a given party. As will become clear in our model, the main results depend on the ability of the corporate sector to influence the elections, not on how this is influence is achieved. One example of an institution that allows for monetary contributions is a legal framework that institutionalizes them, while an example of an institution that allows for contributions in kind is a regime of legal private media.

[54] One may ask: why do we assume that only firms offer campaign contributions? The important issue, from our perspective, is whether the firm sector is sufficiently more influential in elections than the labor sector. Our results do not change if we also allow for campaign contributions of labor unions. If the campaign contributions of firms are sufficiently more influential than the contributions of labor unions, then the results of our model follow. We assume that, unless legal, institutional and technological constraints prohibit any type of influence, firms will generally tend to be more influential in elections, for

move after the policy is chosen, contributing (in money or media support) to the governing party or to its rivals. Anticipating this, the governing party will choose not to follow opportunistic policies and firms will choose a high level of investment and society as a whole may benefit.

The question about the effects of campaign contributions on economic efficiency is especially important because in the recent years its role has been extensively discussed in the United States and other countries and many types of campaign finance reform have been proposed. Consequently, political scientists, economists and other social scientists have been examining the economic and social implications of campaign contributions. For example, Levitt (1995) refers to three main criticisms of the system of congressional campaign finance in the United States. First, fundraising is an important activity for candidates, which requires too many resources, especially in terms of the time constraints of politicians; hence they may not be able to carry out their more important tasks. Second, it is argued that the system of contributions and fundraising may be biased towards incumbents. Thirdly, an important consideration is whether organized interest groups exert excessive influence on politics. To these arguments one may add that the system is may be biased towards right-wing candidates, since the majority of special interest groups are thought to relate to the corporate sector. Finally, an additional criticism asserts that increasing campaign money, after some level of expenditure has

two reasons. First, the monetary contributions of the firm sector are usually higher than those of labor unions, and second, owners of private media tend to have more connections with private firms than with labor unions. Of course, we do not claim that the results of our model are universal; if in a specific economy some of the assumptions we make are not true, then the model is not relevant for this economy. We do believe that our assumptions are reasonable and relevant for a large class of economies.

been made, has no important effect on social welfare; therefore there is a waste of resources. These are just some of the arguments against campaign contributions.

There are some moral arguments in favor of campaign contributions, such as freedom of speech and the value of independent (from the state) political parties in democracy. The discussion concerning the potential positive economic effects of the institution of private campaign contributions has been growing, partly because of the previously mentioned criticisms. Theoretical papers have considered conditions, under which, the institution of campaign contributions contributes to economic efficiency. In particular, it has been argued that contributions may inform voters about the quality of candidates or their exact positions in the political spectrum. This can be done with two ways: either political advertising is directly informative of the qualities of politicians,[55] or it signals a hidden ability of a candidate that the voters do not observe but the interest groups do.[56] However, the arguments of the first type do not answer one basic question, namely why society tolerates special interest contributions, because the perceived benefits of information come from campaigning in general, privately or publicly funded. However, the signaling literature does offer an argument for the efficiency of *private* campaign contributions.[57]

This paper explores an alternative argument for the efficiency of private campaign contributions that does not necessarily contradict the information argument. Attention will be focused mainly on policies affecting the returns to capital and on possible

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[55] The papers by Austen-Smith (1987) and Coate (2001) are representative of this literature.
[56] See Prat (1999).
[57] We shall discuss the literature more in the next part.

commitments referring to these policies. In the absence of campaign contributions, the incumbent party will choose opportunistic policies despite the fact that the commitment outcome is better for the economy if commitment cannot be directly enforced. Accordingly, rational firms would not invest and the economy would be trapped in a bad equilibrium because direct commitment is impossible in the political process.[58] However, under commitment, the incumbent party would respect its promises because otherwise it will be penalized and significantly undermine its reelection prospects. The important result is that society as a whole, including people who earn mostly labor income, may benefit from the establishment of this institution. This is despite the fact that the resulting corporate influence in elections may work against the choice of a labor-friendly policy. The reason is that in the long run the whole economy will benefit enough from the higher level of investments in the economy, which is attained by enforcing the commitment to a more capital-friendly policy. Campaign contributions can therefore substitute for direct commitment when is impossible to enforce such commitment.

In part 3.2 the relationship between our model and the existing literature is discussed. In part 3.3 the setting of the formal model is presented. The benchmark case of credible commitment is discussed in part 3.4. In part 3.5 the equilibria of the subgames with and without campaign contributions are found and it is shown that in the unique equilibrium of the whole game voters approve the institution of campaign contributions. The results are discussed in part 3.6. We briefly present some examples from specific economies, in which our model is relevant, in part 3.7. Part 3.8 concludes.

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[58] The book by Dixit (1996) thoroughly examines the implications of this idea.

3.2 Related Literature

Kydland and Prescott (1977) underline the importance of policy rules that are unalienable except under very extreme conditions. This importance stems from the well-known problem of time inconsistency that occurs when policy-making is a dynamic process. If this idea is true in real economic policy, then policy rules and commitment are important. Hence, one may be interested examining these specific institutions that ensure that policy rules are enforced.[59] One very important example of such an institution is the independent central bank with a "conservative director". We argue that private campaign contributions can be understood as an institution attaining similar results.

Our idea resembles the notion of strategic delegation, which is discussed in Person and Tabellini (1994). This refers to the electoral support by some voters of candidates that may not share their preferences about policy. This can be the case when, for example, the elections cannot be won by candidates that share the preferences of these voters. A model with similarities with our model is presented in Person and Tabellini (1994) pp. 318-323. Here, middle-income voters may vote for candidates that would protect the profitability of capital more than they themselves would like to. This is because after elections take place, capital accumulation decisions are made on the basis of predictions about policy, which is enacted subsequently. These accumulation decisions affect the welfare of all, as in our model. Thus, Person and Tabellini also view this

[59] It is worth noting that commitment may not necessarily require the existence of an institution. Reputation-building might be enough to ensure that politicians will not behave opportunistically. The literature on reputation is large. See, for example, Person and Tabellini, pp. 314-315.

seemingly paradoxical mechanism of strategic voting as enforcing society's commitment on policies that induce investments.

The notion that wage earners may like an institution that protects the rights of capital has been examined in the political science literature. This is closely related with the idea of "structural dependence" of democratic governments on capital. This view claims that the policy-making of a modern democratic state is structurally constrained; this is because investment decisions of wealth holders affect the future economic conditions for the economy as a whole.[60] Therefore governments have to take into account the effect of their policies on investments and growth and voters realize this. Przeworsky and Wallerstein (1988) introduce and test the idea of structural dependence using a formal model. They show that without effective government intervention, wage earners are constrained in their demands. They also show how a tax on consumption of profit-earners can relax this constraint, invalidating "structural dependence". Yet, in the dynamic setting, where expectations matter, governments are constrained for the usual reasons of credibility of promises for capital accumulation.

The literature on monetary campaign contributions is large as well. In terms of its structure, our model has similarities with the model of Snyder and Ting (2005). They also use a model with voters, (a representative voter) interest groups and parties to examine the importance of elections as a means to control the performance of politicians. However, their focus is mainly in comparing the incentive to control performance versus the incentive to elect good types of politicians. It is interesting to note that they use an

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[60] See Przeworsky and Wallerstein, (1988).

alternative assumption regarding the effect of a contribution or a “bribe”. A “bribe” from the interest group directly increases the utility of the party, whereas in our model it only affects the probabilities of reelection.

It has already been said that the economic effects of campaign contributions have been examined in the literature. One important strand of the literature examines informative advertising. These papers assume that money spent on campaigning may promote advertising that increases voters’ knowledge about the candidates’ abilities or positions. Austen-Smith’s work (1987) is the first that tries to explain the existence of campaign contributions assuming informative advertising. He notes that advertising for a particular candidate decreases the uncertainty that risk-averse voters face regarding his policy position, making this candidate a better choice. Coate (2001) argues that when advertising is informative - for example when it presents verifiable records of the candidates’ deeds - campaign contributions may promote the choice of a candidate that moderates like. This is done when the two parties choose partisan or moderate candidates. Advertising can induce the choice of moderates because the group of swing voters prefers them, but they need information about the ideology of candidates. In other words, parties get away with choosing partisans only if moderate voters do not get information through advertising.

A different approach has been to consider campaign advertising as a signal. Pratt (1999) develops a formal model that assumes that the valence of candidates is more known to the special interest groups than to voters. Accordingly, these groups are more likely to contribute to better candidates since they know that these candidates are more likely to win. This implies that the level of contributions a candidate gets signals his type. Allowing campaign contributions may be efficient if the benefits of this information for society exceed the costs of distorting the political promises of candidates. Hence, this model derives a rationalization of the institution of campaign contributions by special interest groups, unlike the directly informative advertising models. Our model also offers a natural explanation for this institution in terms of efficiency.

3.3 The Setting of the Model

The main ideas are analyzed in a simple model with investment decisions, policy choices and elections. Following a large strand of literature, and in particular Kiewiet and Rivers (1984, p.7), we assume that voting is retrospective, responds to actual policy outcomes, and is incumbency-oriented in the sense that voters seek to discipline or reward incumbents for their economic policy. We show that if corporate campaign contributions are not institutionalized, in which case they are illegal and we assume they do not exist, the time inconsistency problem makes the incumbent party choose a labor-friendly policy. This is because we assume that the constituency consists of wage-earners that prefer such a policy. Anticipating this, firms do not invest and all players are worse off. If the government could commit to the capital-friendly policy this would improve social welfare, but without legal campaign contributions the enforcement of this commitment is not possible. Consequently, voters accept the existence of this institution because it makes them better off.

3.3.1 The Players and the Pure Strategy Spaces

There are two parties, an incumbent party (I) and a challenger party (C). There is one group of voters, the middle class (M), which has a continuum of voters. Finally, there is the firm sector (F). Player C, the challenger party, never gets to move in our model but is used for expositional reasons.

This is a simple four-stage model. In stage zero, voters vote whether to accept or reject the existence of the institution of private campaign contributions. We shall explain later what this institution exactly does. The pure strategy space of voter j in stage zero is $\{a,r\}$, where a denotes accepting the institution of private campaign contributions and r rejecting them. In stage one the firm sector decides whether to choose a high or low level of investment. Denote with x the level of investment, where $x=h$ means that the investment is high and $x=l$ means that the investment is low. The firm sector at that point knows the choice of voters at stage zero, so that the pure strategy space of F in stage one is the set of all functions mapping $\{a,r\}$ onto $\{h,l\}$ that is, the set $\{hh,hl,lh,ll\}$. For example, lh is the strategy "choose low investment" if a was the majority decision in stage zero and "choose high investment" if r was decided by the majority.

In stage two the incumbent party I decides whether to implement labor-friendly policy or employer-friendly policy. Denote by s the policy choice, where $s=L$ means labor-friendly policy and $s=E$ means employer-friendly policy. Since the party knows both the voters' choice and the firms' choice at the previous stages, the pure-strategy space for the incumbent party is the set of all mappings of the form $f:\{a,r\}\times\{h,l\}\rightarrow\{L,E\}$. In stage three, elections take place and voters decide if they vote for the incumbent or the challenger party. Notice that voters differ within the group. So any pure strategy equilibrium must specify a pure strategy for each voter of the group. Accordingly, the pure strategy space of voter j is the space of all mappings of the form $q:\{a,r\}\times\{h,l\}\times\{L,E\}\rightarrow\{V_I,V_C\}$. All equilibria we will find are pure strategy equilibria.

3.3.2 The Payoff Functions

Firms: the payoffs of firms are their profits, realized in stage two. They depend on whether they invested or not and on the policy choice of the incumbent party. Let $\pi(s,x)$ be the profit function of firms. The critical property of this function is the following:

Assumption 1: $\pi(L,l)>\pi(L,h)$ and $\pi(E,h)>\pi(E,l)$

This says that if the policy is labor-friendly the firm sector is better off having invested low and if the policy is capital-friendly the opposite is true. This seems reasonable given that investments entail some fixed costs and increase productive capacity. The function π incorporates these costs here. If the variable costs of production are high enough, then the optimal choice of the firm sector is not to produce a large quantity. It is a logical assumption that variable costs depend on minimum wages, insurance regulations, capital taxation and more parameters that are incorporated in the policies E and L.

Parties: the payoff of the two parties is a fixed amount Ω that they get if they are elected in stage three. They get zero if they are not elected. We assume that the utility from choosing any level of policy in stage two is zero. In other words, parties have no preference for any particular policy. This assumption is not necessary for the results.

Voters: the payoffs of voters are additive and they depend on which of the two parties gets elected.

For agent j in the utility function is:

$$u_j(s,x,\sigma_j,\delta) = v(s,x) + p(s,x) + \sigma_j + \delta \quad \text{, if } I \text{ wins.}$$

$$u_j(s,x,\sigma_j,\delta) = v(s,x) \quad \text{, if } C \text{ wins.}$$

We shall explain in detail what these different terms mean and their important properties. First of all, the utility of voters depends on the current policy and investment according to the payoff function $v(s,x)$ enjoyed in stage two. The important thing to note is that this term does not depend on who gets elected: it is simply the realized payoff, that is, the utility of consumption goods. This term therefore does not affect the elections but it does affect the welfare properties of equilibria.

Assumption 2: $v(s,h) > v(s,l)$ for any s and $v(L,x) \geq v(E,x)$ for any x

The first condition says that that for all voters the situation where investment is high is preferable to the one where investment is low, regardless of the policy chosen. Intuitively, this means that middle-income voters are better off in a thriving economy with capital-friendly policy than in a shrinking economy with a labor-friendly policy. The second condition says that ceteris paribus, voters prefer the labor friendly policy. It should be clear that we have made the assumption that all voters are principally wage earners and they do not earn profits. The owners of firms have mass zero.[61]

The function $p(s,x)$ captures the fact that voters seek to discipline or reward the incumbent party for policies that affect the economic performance of the economy and their individual economic condition.[62]

Assumption 3:

a) $p(L,h) > p(E,h)$ and $p(L,l) > p(E,l)$

b) $p(s,h) \geq p(s,l)$ for all s

The first statement represents the psychological fact that, ceteris paribus, voters prefer voting for the incumbent if he follows the policy that they prefer, namely the labor friendly policy. The second statement says that voters reward the incumbent for encouraging investments and general prosperity in the economy. It is worth noting that this psychological effect is stronger than the willingness to reward or punish the incumbent for the chosen policy, because $p(E,h) \geq p(L,l)$ which means that voters will reward an incumbent party for having achieved high investments, even if it follows an employer-friendly policy. As we shall show, despite this strong assumption, the incumbent party fails to choose employer friendly policy in the absence of a commitment device.

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[61] This only strengthens our final result that voters support the institution of campaign contributions. Including a rich group would complicate the model and weaken some of the assumptions, but would not change the results.

[62] This is justified if we consider the effect of the general economic conditions in the popularity of incumbents according to the models of retrospective voting. There is much evidence that shows that voters punish the incumbent party both for bad macroeconomic performance and individual low income in a retrospective manner: see Kramer (1971) and the surveys by Monroe (1979) and by Kiewiet and Rivers (1984).

The parameter σ_j captures individual heterogeneity. Voter j has a specific individual preference for one of the two parties that does not depend on the expected policy of the two parties. This might be due to ideological preference or due to preference over a policy of the two parties that is fixed. σ_j follows the uniform distribution in $\{-\frac{1}{2\varphi}, \frac{1}{2\varphi}\}$ where the support $\frac{1}{\varphi}$ is large. The use of these parameter helps smooth the results.

Finally, the random parameter δ represents the general popularity of the incumbent party relative to the challenger party that is unknown before the elections and it follows the uniform distribution in $\left\{-\frac{1}{2\theta}, \frac{1}{2\theta}\right\}$. The realization of δ can be affected by random elements of the political process, such as performance the final debate between the political leaders.

3.3.3 The Institution of Campaign Contributions

To describe this institution without complicating the analysis too much, assume that the firm sector can finance the campaign of the incumbent or the challenger party – a decision that depends on the policy choice of the incumbent party. What the firm sector wants is the choice of policy E in stage two. Firms have the option, before stage two, to convey the message to the incumbent party that if it chooses a policy L they will contribute the monetary amount c to party C and if it chooses policy E they will contribute the amount c to party I. Thus the incumbent party knows this before it chooses the policy. To provide this kind of incentives clearly makes sense and we shall not further discuss the choice of the optimum contribution scheme here. We also assume that the firms can commit in honoring their promise. This can be justified if we interpret the group F as a long-run player, who is interested for reputation building, and the politicians as short-run players.

For simplicity, assume the aggregate popularity of the incumbent increases in a well-defined way with contribution money and this is the same for both groups of voters. In particular, a fixed monetary amount c to the campaign of the chosen party is contributed, and it has the psychological effect of adding a fixed amount $e(c)$ to the utility of all voters if the supported party gets elected. This is, for example, because they are used for persuasive television advertising, and thus they create a positive impression for this party.

Assumption 4: $e(c) \geq \frac{p(L,x) - p(E,x)}{2}, \forall x$

This simply says that contributions have a substantial effect on the utility of voters, meaning, for example, that advertising is very persuasive. In particular, it is persuasive enough to induce voters to vote for the incumbent party despite the fact that it chose an employer-friendly policy.

3.4 Equilibrium when Commitment is Possible

Illustrating the main ideas, let's forget stage zero and the possibility of campaign contributions. We shall briefly consider the subgame in stages one to three only, without the possibility of campaign contributions. This is in order to show that that the theoretical argument about policy rules of Kydland and Prescott is valid in this case, but its enforcement is not trivial. Assume that commitment to a certain policy is costless. We want to examine whether, in this game, the incumbent party would be better off in the equilibrium with discretion or committing about the policy it will follow in stage two, before the investment decision in stage one, would improve its position.

Claim: Under assumptions 1 and 3, if the incumbent party commits to follow the employer-friendly policy in stage 2, it improves its position relative to the case where it does not commit. If assumption 2 additionally holds, then everybody is better of in this commitment equilibrium.

Proof/ Clearly, the equilibrium payoffs of the incumbent party depend only on the equilibrium probability of the incumbent party winning. Proposition 1 in the next section describes the equilibrium without commitment in this game. Using its results, we know that the probability of the incumbent winning is $P(L) = \frac{1}{2} + \theta \ p(L,l)$. If, however, this party could commit, before the investment decision, to choose employer friendly policy in stage two, then assumption 1 ensures that $x = h$ and therefore the probability of its victory would be $P(E) = \frac{1}{2} + \theta \ p(E,h)$. So, the commitment outcome is preferable for the incumbent party by assumption 3(b). By assumption 2, all voters are also better off with commitment that without commitment.

This is a strong result that affirms that rules are better that discretion, especially when it comes to capital taxation. The important issue here is how to achieve this result, or at least approximate it with some cost, when a direct contract stipulating the commitment arrangement is prohibited by law and any agreement is likely to bear the negative suspicions of corruption. As the theorem shows, campaign contributions are likely to achieve this outcome.

3.5 Equilibrium when Direct Commitment is not Possible

For this section, consider the whole game, in stages zero through three.

Theorem: In the unique subgame perfect equilibrium of the game all voters vote to allow for the institution of campaign contributions. The equilibrium strategies for all players are:

1. The choice of all voters is to approve (a) private campaign contributions in stage zero.
2. The strategy of F in stage one is hl (firms invest only if the institution has been approved).
3. The policy function of I in stage two is the following: $f(a,h)=E,\ f(a,l)=E$ $f(r,h)=L,\ f(r,l)=L$. This means that the incumbent follows the employer friendly policy when the institution of private campaign contributions has been approved and the labor friendly policy otherwise.

To prove this result we shall prove two propositions about the equilibria in the two subgames that start at stage one.

Proposition 1: In the subgame after voters reject the institution of campaign contribution at stage zero, under assumptions 1 and 3, there exists a unique subgame perfect equilibrium and the following pure strategies are equilibrium strategies for F, I:

- l for F at stage one,
- LL for the incumbent party at stage 2 (the incumbent chooses a labor-friendly policy no matter the investment choice of the firms).

Proof/ Backward induction will be used. We shall start by considering the voting behavior at stage 3. The problem of voter j is trivial. She votes for I if the utility from doing so is greater that the utility from voting for C.

$$v(s,x) + p(s,x) + \sigma_j + \delta > v(s,x) \Rightarrow$$

$$p(s,x) + \sigma_j + \delta > 0 \Rightarrow \sigma_j > -[p(s,x) + \delta]$$

This holds for all voters. Therefore, given s and x, there will be a swing voter who is indifferent between voting for I and voting for C. The ideology parameter for this voter shall be $\sigma_{j*} = -[p(s,x) + \delta]$. Clearly, all voters with ideological parameter more than σ_{j*} vote for the incumbent party. Accordingly, the share of voters that vote for I is $\Pi = \frac{1}{2} - \phi\sigma_{j*}$.

Since δ is still random, what the incumbent wants is to maximize is his probability of winning. This is equal to the probability that his share of total votes Π exceeds $\frac{1}{2}$.

$$\Pr(\Pi \geq \frac{1}{2}) = \Pr\{\phi[p(s,x) + \delta] \geq 0\} = \Pr\{\delta \geq -p(s,x)\}$$

But given the distribution of the parameter δ, the probability that it exceeds a given number c is $\frac{1}{2} - c\theta$. Finally, the probability of the incumbent winning given s, x already chosen is $P = \frac{1}{2} + \theta \; p(s,x)$.

Now, at stage two, the incumbent party anticipates this behavior of voters and chooses the policy that maximizes its utility. Since its utility depends only on the result of the elections, it simply seeks to maximize its probability of being elected.

If it chooses policy L, its probability of winning is $P(L) = \frac{1}{2} + \theta \; p(L,x)$.

If it chooses policy E, its probability of winning is $P(E) = \frac{1}{2} + \theta \; p(E,x)$.

Therefore, the incumbent party chooses the labor-friendly policy since by assumption 3(a), $P(L)$ - $P(E) > 0$. The optimal strategy for I is LL, that is, choosing a labor-friendly policy no matter what. The firms rationally anticipate this, so they invest low in stage one, since assumption one implies that they would reduce their profits if they invested high. So the optimal strategy for F is l. *QED*

Note that the policy choice does not depend on the investment level x. When the policy is considered, investment decisions are already made, and although they can make the incumbent party more popular, they cannot affect its optimal decision. This result is intuitive: the labor-friendly policy politically benefits the incumbent party since voters prefer this policy and the investment level is given. In a similar argument like in Kydland and Prescott, the government, in the absence of commitment, loses any control over the expectations of the firm sector, which are $s^e = L$ no matter what.

Proposition 2: Under assumptions $1, 3$ and 4, there is a unique subgame perfect equilibrium in the subgame where the institution of legal contributions is approved at stage 0, and the following pure strategies are equilibrium strategies for F, I:

- For F at stage one, $x = h$
- For the incumbent party at stage two, EE

*Proof/*Again, backward induction is used. In this setting, the preferences of voters in stage 3 depend on the policy for one additional reason: choosing $s = E$ implies that F contribute to the campaign of the incumbent, and $s = L$ implies that F contributes to the campaign of the challenger party.

So, if $s = E$, the utility function for agent j is:

$$u_j(s, x, \sigma_j, \delta) = v(s, x) + p(s, x) + \sigma_j + \delta + e(c) \qquad \text{, if } I \text{ wins.}$$

$$u_j(s, x, \sigma_j, \delta) = v(s, x) \qquad \text{, if } C \text{ wins.}$$

It is readily verifiable that now the probability of I winning is

$$P'(E) = \frac{1}{2} + \theta \, \{p(E, x) + e(c)\}$$

If $s = L$ the utility function for agent j is:

$u_j(s, x, \sigma_j, \delta) = v(s, x) + p(s, x) + \sigma_j + \delta$, if I wins.

$u_j(s, x, \sigma_j, \delta) = v(s, x) + e(c)$, if C wins.

The probability of I winning is $P'(L) = \frac{1}{2} + \theta \{p(L, x) - e(c)\}$.

Again, the incumbent party, anticipating the behavior of voters in stage three and hence these probabilities, will follow the employer friendly policy if $P'(E) - P'(L) \geq 0$, which implies that $2e(c) \geq p(L, x) - p(E, x)$. This holds by assumption 3, which says that the effect of campaign contributions in persuading voters is large. Thus, the incumbent party, under this contribution schedule of the firm sector, maximizes its reelection probabilities if it chooses the employer-friendly policy at stage 2. Once again, the optimal strategy of party I does not depend on whether investments took place or not in stage one. We conclude that under legal campaign contributions the optimal strategy for the incumbent party in stage 2 is EE. Finally, rationally anticipating this, the firm sector shall invest high in stage one by assumption 1. *QED*

The second and third parts of the theorem have already been proven. To prove part one, notice that the equilibrium payoffs of voters at stage 2 in the subgame with contributions is $v(E, h)$ and in the subgame without contributions it is $v(L, l)$.[63] From

[63] We assume that the utility stemming from the election result, that is, all other components of the utility functions are small relative to the realized economic payoff of period two. These are of course important for determining the electorate preferences of voters, but not a significant component of overall utility.

assumption two, $v(E,h) \geq v(L,l)$ so voters are better off, if they approve the institution of campaign contributions at stage 0. This proves the theorem.

3.6 Discussion

The plausibility of assumption 4 should be discussed because there is an important debate regarding the importance of money and media in politics. Conventional wisdom is that money buys important political influence. This conviction is so strong that Gary Becker, in his influential work about pressure groups competing for political influence (1983), p.392, did not include voting at all. He justifies this by the following:

> *"[I] … have presented a theory of rational political behavior, yet [I] have hardly mentioned voting. This neglect is not accidental because I believe that voter preferences are frequently not a crucial, independent force in political behavior. These 'preferences' can be manipulated and created through the information and misinformation provided by interested pressure groups[…]"*

(The emphasis by the author). This is just an example of the conviction that most people and scholars share, that is, that interest groups have strong effects on voting. After all, parties spend important amounts of money for political campaigning. It comes as a surprise, therefore that social scientists have not managed to substantiate the importance of media exposure and campaigning for voter preferences, which are found to have "minimal consequences". Moreover, authors like Snyder, Ansolabehere and Figueiredo (2003) argue that money is not very important in politics in the sense that large contributors do not seem to be successfully "investing" in contributions. Their basic argument is that the amount of money spent on campaign contributions does not even reach the legal limits and is dwarfed by the amounts of money at stake when economic policy is decided. At the same time, the bulk of campaign contribution money in the US originates from small contributors. They conclude that money cannot buy that much influence.

However, this inability has been the result of methodological and conceptual limitations, as many authors have shown, and the results of experimental studies have been reinforcing the view of important, rather than minimal, effects of campaigns. Bartels (1993) claims that data and methodology limitations have prevented social science from capturing the apparent importance of media effects. He proposes ways to fix this using a model of informative campaigning with estimation of errors. Iyengar and Simon, (2000) ascribe the inability of academic research to demonstrate the effects of political campaigning to both methodological and theoretical problems. These include some of the typical disadvantages of survey studies, (in particular that measuring "media exposure" is prone to bias and error), the fact that media effects exist in a large span of time, and the fact that they interact with the previous positions of voters in complex ways. They also claim that the conventional conceptual approach to campaign effects is excessively restrictive and if all effects are taken into account the real importance of campaigns is revealed. To all these we have to add the large literature that shows that special interests contribute as if they expect something in return, results which even Snyder, Ansolabehere and Figueiredo (2003) accept. Summing up, we believe that the effects of money and media effects are significant, although they cannot easily be substantiated.

The assumption of non-partisan politicians is not critical. The results of the model would not change if elections were between partisan politicians and in particular a leftwing partisan candidate and a right-wing partisan candidate. In such a case, the two candidates have a strong incentive to follow their preferences no matter what they have promised. Assuming a single group with middle-income voters simplifies the analysis but is not necessary for the results. On the contrary, relaxing it would strengthen the results: if a second group of rich voters, who prefer the employer-friendly policy even in the short run, was assumed, then the critical assumption 4 would be weakened. This is because the psychological effect of advertising would not have to counter the whole effect of preference for the labor-friendly policy, because the rich voters would prefer the employer-friendly policy. Of course, the relative political clout of the rich group would determine the necessary size of the contribution effect $e(c)$.

In what types of polities are the results in this paper likely to apply, and thus the insights from our model instructive? The existence of problems of time inconsistency, especially with respect to capital taxation and macroeconomic stability, seems to warrant commitment solutions. Hence, countries with strong left parties and a tradition of populist governance are more likely to require devices such as the one described in this paper for promoting investments. For example, some Mediterranean European countries like Spain, Portugal and Greece have a tradition of political tension between left and right with a strong left[64] and a relatively low ability to achieve cooperation.[65] In these counties, the transition into a regime of stable economic policy has taken place in an era with much more important role of private television in electoral campaigns. Presumably, this

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[64] See Golden(1986).

[65] The Mediterranean countries, especially Greece, seem to have low levels of social capital. See Christoforou (2003) and Tsakalotos and Lyberaki (2002).

significantly increased the potential for electoral influence of the private sector. It may seem that the institution of private campaign contribution can serve as an appropriate tool for economic policy change and growth in such cases. The second example that we shall present describes the case of Greece.

Furthermore, the importance of the commitment device we are proposing depends on the ability of a society to coordinate, or social capital. For example, the small Nordic democracies of Europe (Sweden, Denmark, and Finland) have a strong ability of policy coordination at the economy-wide level and they also score high in social capital indices. This political coordination system, corporatism, decreases the need for other commitment devices. Hence, it is not a surprise for our model, that campaign contributions and media influence of firms do not play a serious role in politics in these countries. Finally, it is worth noting that our model has something to say even for countries that do not seem to have a current policy credibility problem, such as the United States. In particular, it may explain why this institution emerged in the first place. As our first example illustrates, the historic circumstances where this happened may well be similar with the contemporary conditions in countries that use this commitment device.

3.7 Examples

3.7.1 The US Example

We argue that the economic prosperity achieved in the U.S. after 1896 was achieved with the help of the commitment device this paper discusses. In particular, the ability of the firms to contribute to the party that promised to maintain the gold standard guaranteed the economic and financial stability of this international monetary system and this contributed to the good condition of U.S. economy. Adam Winkler (2004) underscores the effect of firm contributions in the US elections of 1896, where William Jennings Bryan ran a campaign based on the populist platform of free silver. Cited from Winkler:

"*Bryan's proposal to move the dollar off the gold standard and allow free coinage of silver profoundly worried major industrial and financial concerns, which believed free silver to be a risky monetary policy that would endanger the economy. Playing upon those fears, McKinley's campaign chairman, Hanna, pushed the heads of major corporations and other business combines to donate generously to the Republican campaign – 'assessments' based on the size of their capitalization and their "stake in the general prosperity." Standard Oil, the largest corporation of its day, was asked to pay $ 250,000*"

Indeed, many economic and financial interests seriously worried about the proposals of the populists, and most analysts, including Irving Fisher and Milton Friedman, agreed that the monetary policy of the populists was indeed problematic. Friedman (1990) discusses the scholarly views on the subject of bimetallism and on the actual proposals of the populists. He notes that even scholars who in theory supported bimetallism rejected the specific proposals of the time. Friedman himself said about the policies of the populists (pp. 95-96):

" *While I believe that 16:1 was feasible for the U.S. in 1873, by 1893 it was surely too late to undo the damage : Bryan may have been trying to close the barn door after the horse has been stolen*".

This was the period of one of the worst depressions in American history, and this uncertainty about money made things worse. In the framework of our model, investments in the economy would be particularly low in the absence of campaign contributions. This is because by catering for the interests of the middle income group, mainly farmers, the Democratic-populist candidate would increase his probably of winning. However, with campaign contributions the incumbent party was able to commit on continued adherence to the gold standard, alleviating the fears of the firms and winning the election. The prosperity that followed indicates that the commitment device worked. The economic conditions following the victory of the Republicans were extremely good[66] and it can be claimed that there was an amazing reversal of fortune for the U.S. economy. Although other factors may have also contributed to this success, a large part of the good economic outcomes can be attributed to the feelings of monetary and financial stability that the preservation of the gold standard created. Even scholars, who do not believe that the preservation of the gold standard was a sufficient policy for this success, admit that the stability it achieved was necessary.

Furthermore, the economic regime that Hanna's efforts and firms' campaign contributions help protect can be safely characterized as one of commitment and macroeconomic stability. Bordo and Rockoff (1996) underscore the importance of the gold standard as a commitment mechanism for financial discipline as well as for achieving beneficial terms of international financing. According to their account, when a country held firm the gold standard despite the vicissitudes of economic conditions this gave the European countries of the financial core a clear message about the stability of the country, which thus achieved good borrowing conditions. In addition to that,

[66] Noyes (1905) offers a good account of his county's contemporary achievements: "*How the United States managed so to reverse its position in the past ten years that, instead of the crippled industrial and financial state of 1894…we have seen in the short space of half a dozen years, a community whose prosperity had become the puzzle of the outside world*…"

maintaining the gold standard was critical for the international economic relations of the country. Rosenberg (1985) emphasizes "gold standard diplomacy" in the period after 1900 as an important part of the policies that the US followed to increase its international influence.

It is worth noting that one need not engage in the debate about the monetary plan of the populists. Since the private sector's expectations were formed on the basis of the conviction that Bimetallism was a precarious monetary system, this would be enough to deter investments. Finally, we should note that this is a vastly simplified account of a very complicated historical fact, one of the most debated elections in American history, but it provides a useful way to think about it.

3.7.2 The Greek Example

The second example concerns the change in economics policy of the Greek liberal party PASOK (Pan-Hellenic Socialist Movement). [67] Greece was doing relatively poorly economically in the 1980's, when the dominant party, PASOK did not have long run relationships with the private sector.[68] On the other hand, the recovery of the economy starts from the period where the first traces of increasing corporate political influence appear. In the 1990's, the same party, PASOK, implemented a much different economic policy, achieving macroeconomic stability and high growth, at the same period when

[67] Greece is a country with strong tradition of political polarization and, at the same time, lack of social capital sufficient to achieve coordination of the corporatist type (see Golden 1986 p. and Featherstone 2005, p.232). This means that in Greece social cooperation is hard to achieve.

[68] Corruption scandals, such as the Koskotas' great scandal only involved publicly held corporations.

accusations of corruption became widespread.[69] We argue that the change in economic policy of PASOK can be attributed to a change into a commitment regime after 1993 generated by campaign contributions in kind (media support).

In the 1980's populist leader Papandreou's party, PASOK, governed for eight years following an economic policy that has been heavily criticized, especially with regard to issues related with the protection of property rights and for failing to achieve positive corporate environment and macroeconomic stability (see Bosworth and Kollintzas, 2001). In the late 1980s' increasing international pressures for a free media world persuaded Greek politicians to institutionalize private media. We argue that this change in the media allowed for a higher influence of strong interests in elections, which served as a commitment device for PASOK. Greek elections were transformed to media-controlled "couch elections" according to Greek reporters. Yannas (2001) discusses the significant increase in the party spending for television advertising: in the election of 1990, PASOK spent 6.7% of its advertising expenditures for television advertising. After 1993, this percentage surpasses 75% Yannas (2001, p.4).

In 1990-1993 the conservative New Democracy party governed, under the leadership of Konstantinos Mitsotakis, a fervent opponent of Papandreou's polices. This party followed a policy for economic adjustment with radical steps: rapid privatization, changes in social spending, labor market changes, and more. The result was that labor union opposition was so great that the economy could not operate. This government was overthrown in 1993 by the influence of, according to the prime minister himself, special

[69] In fact, one of the major campaign promises of the winning 2004 party, New Democracy, was that corruption of the form of media and business interest political influence cannot be tolerated any longer.

interests related to corruption. The interpretation one can make of this is that the rightist government was so inefficient that the private sector preferred the PASOK government, which under the force of the new, media-driven political race, would be willing to reach a long-run relationship with them. Macroeconomic stability and greater protection of property rights is something that business firms would require from the government, and now PASOK did not feel it could win elections only with the famous appeal of its charismatic leader Papandreou, but had to increase its political campaign spending and get control of the media.

PASOK won the elections in 1993 and governed for 11 consecutive years. The kind of economic policy adopted was stabilizing and conservative and the economy attained the satisfaction of the macroeconomic criteria for joining the European Union in 1999. Featherstone (2005) surveys the key components of Prime Minister Simitis' "modernization" project: privatization, labor market reform, smaller and more efficient state, and macroeconomic stability. Throughout this period of 11 years corruption and corporate influence accusations resounded in the Greek political life.[70]

This historical example can be very accurately depicted in our setting. Before the change in the media sector in 1989, television advertising did not exist, so the effects of campaign contributions were insignificant: $e(c)$ was very low for any c. Accordingly, campaign contributions played no role before 1989. PASOK had an advantage and won,

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[70] It is worth noting that in a very influential paper about the Greek economy, Alogoskoufis - in Alogoskoufis, Giavazzi, and Laroque, (1995) - argues that the bad performance in the Greek economy in the period 1974-93, compared to the period 1954-1973, was due to the change in economic regimes. He agrees with our paper in emphasizing the inability of the new regime in 1974-93 to achieve cooperation and commitment.

choosing labor-friendly policy, and at the same time, investment was low, exactly as our model predicts. The electoral defeats of 1989-1990 were a special case due to massive scandals and the general desire of the public for political catharsis. After PASOK got reelected in the early nineties, private television was a reality and $e(c)$ was high enough so that assumption 4 was satisfied. As our model predicts, the chosen policy was capital-friendly, investment was high and PASOK apparently enjoyed the support of the biggest media owners and editors, and was thus reelected twice.

3.8 Conclusions

We used a model to examine how the institutionalization of legal corporate campaign contributions can ameliorate the credibility problem in economic policy and achieve something close to the commitment outcome (at some cost). We concluded that this could be achieved under some assumptions regarding the importance of campaign contributions for shaping political preferences. This result is more relevant for specific democracies, especially those prone to opportunistic political manipulation and insufficient social capital. We illustrated this by presenting two examples. First, we showed how our framework could shed some new light one important electoral race of the USA, the famous "populist versus republicans" race of 1896. In our framework, Hanna's much criticized collection of corporate contributions may have helped the economy attain its good results in the following decade. Then we discussed the example of Greece; a country plagued by economic instability in the 1980's which experienced an impressive reversal of its economic policies in the 1990's under the same party. We attribute this reversal partly to the increase in the electoral influence of corporate interests because of the changes in the media landscape.

The practical significance of the results of this paper is that the existence of a strong influence of the corporate sector in many countries can be understood under the view of economic efficiency attained with this institution. It must be emphasized that this analysis does not imply that any society should permit unlimited electoral influence of corporate interests. It just gives one argument for the possible economic efficiency of institutions that allows for some influence. The criticisms mentioned in the introduction may well be valid and, depending on the value system of a society, they may weight much more heavily that economic efficiency. Political equality and transparency are two principles that have great importance in their own merit, which should not be judged by their economic consequences alone.

REFERENCES

Akerlof, George and William Dickens. “The Economic Consequences of Cognitive Dissonance.” The American Economic Review, Vol. 72, No. 3, June 1982, pp. 307-319.

Alesina, Alberto. “Credibility and Policy Convergence in Two-Party System with Rational Voters.” The American Economic Review, Vol. 8, No. 4, September 1988, pp. 786-805.

Alesina, Alberto. “Macroeconomic Policy in a Two-Party System as a Repeated Game.” The Quarterly Journal of Economics, Vol. 102, No. 3, August 1987, pp. 651-678.

Alogoskoufis, George, Francesco Giavazzi and Guy Laroque. “The Two Phases of Janus: Institutions, Policy Regimes, and Macroeconomic Performance in Greece.” Economic Policy, Vol. 10, No 20, April 1995, pp. 147-192.

Ansolabehere, Stephen, John de Figueiredo and James Snyder. “Why Is There so Little Money in US Politics?” The Journal of Economic Perspectives, Vol.17, No. 1, Winter 2003, pp. 105-130.

Ansolabehere, Stephen, Erik Snowberg and James Snyder. “Television and the Incumbency Advantage in US Elections.” Mimeo, July 2004.

Ball, Sheryl, Catherine Eckel, Phillip Grossman and William Zame. “Status in Markets.” The Quarterly Journal of Economics, Vol. 116, 2001, pp. 161-188.

Banerjee, Abhijit. “A Simple Model of Herd Behavior.” The Quarterly Journal of Economics, Vol. 107, No. 3, August 1992, pp. 797-817.

Bartels, Larry. “Messages Received: The Political Impact of Media Exposure.” The American Political Science Review, Vol. 87, No. 2, June 1993, pp. 267-285.

Battigalli, Pierpaolo and Martin Dufwenberg. “Guilt in Games.” AEA Papers and Proceedings, Vol. 97, No. 2, May 2007, pp. 170-176.

Becker, Gary. “A Theory of Competition among Pressure Groups for Political Influence.” The Quarterly Journal of Economics, Vol. 98, No. 3, August 1983, pp. 371-400.

Berg, Joyce, John Dickhaut and Kevin McCabe. “Trust, Reciprocity and Social History.” Games and Economic Behavior 10, 1995, pp. 122-142.

Bikhchandani, Sushil, David Hirshleifer and Ivo Welch. “A Theory of Fads, Fashion, Custom, and Cultural Change as Informational Cascades.” The Journal of Political Economy, Vol. 100, No. 5, October 1992, pp. 992-1026.

Bohnet, Iris and Richard Zeckhauser. “Social Comparisons in Ultimatum Bargaining”. Scandinavian Journal of Economics 106(3), 2004, pp. 495-510.

Bordo, Michael and Hugh Rockoff. “The Gold Standard as a Housekeeping Seal of Approval.” The Journal of Economic History, Vol. 56, No. 2, June 1996, pp. 389-428.

Bosworth, Barry and Tryphon Kollintzas. “Economic Growth in Greece: Past Performance and Future Prospects.” June 2001, CERP Discussion Paper No. 2852.

Camerer, Colin and Keith Weigelt. “Experimental Tests of a Sequential Equilibrium Reputation Model.” Econometrica, Vol. 56, No. 1, January 1988, pp. 1-36.

Cheung, Yin-Wong and Daniel Friedman. “Individual Learning in Normal Form Games: Some Laboratory Results.” Games and Economic Behavior 19, 1997, pp. 46-76.

Christoforou, Asimina. “Social Capital and Economic Growth: the Case of Greece.” Paper Presented at the 1st Symposium on Social Science Research in Greece of the Hellenic Observatory, June 2002.

Cialdini, Robert B. and Noah Goldstein. “Social Influence: Compliance and Conformity.” Annual Review of Psychology 55, 2004, pp. 591-621.

Coate, Stephen. “Pareto Improving Campaign Finance Policy.” The American Economic Review, Vol. 94, No.3, June 2004, pp. 628-655.

Coate, Stephen. “Political Competition with Campaign Contributions and Informative Advertising.” Mimeo, December 2001.

D’ Agostino, Ralph, Warren Chase, and Albert Belanger. “The Appropriateness of Some Common Procedures for Testing the Equality of Two Independent Binomial Populations.” The American Statistician, Vol. 42, No. 3, August 1988, pp. 198-202.

Daremas, Georgios and Georgios Terzis. “Televisualization of the Politics in Greece.” International Communication Gazette, Vol. 62 (2), 2000, pp. 217-231.

Dimitras, Panagiote, E. “Greece: a New Danger.” Foreign Policy, No. 58, Spring 1985, pp. 134-150.

Dixit, Avinash. “The Making of Economic Policy, a Transaction Cost Politics Perspective.” The MIT Press, Cambridge, Massachusetts, 1996.

Dixit, Avinash; Gene Grossman and Elhanan Helpman. “Common Agency and Coordination: General Theory and Application to Government Policy Making.” The Journal of Political Economy, Vol. 105, No. 4, August 1997, pp. 752-769.

Dufwenberg, Martin and Uri Gneezy. “Information Disclosure in Auctions: an Experiment.” Journal of Economic Behavior and Organization, Vol. 48, 2002, pp. 431-444.

Esponda, Ignacio. “Information Feedback in First Price Auctions.” NYU Mimeo, November 2006.

Featherstone, Kevin . “Introduction: ‘Modernization’ and the Structural Constraints of Greek Politics.” West European Politics, Vol. 28, No. 2, March 2005, pp. 223-241.

Fey, Mark, Richard McKelvey and Thomas Palfrey. “An Experimental Study of Constant –Sum Centipede Games.” International Journal of Game Theory, Vol. 25, No. 4, 1996, pp. 269-287.

Frey, Bruno and Stephan Meier. “Social Comparisons and Pro-social Behavior. Testing ‘Conditional Cooperation’ in a Field Experiment.” The American Economic Review, Vol. 94, No. 5, December 2004, pp. 1717-1722.

Frieden, Jeffrey. “Monetary Populism in Nineteenth-Century America: An Open Economy Interpretation.” The Journal of Economic History, Vol. 57, No. 2, June 1997, pp. 367-395.

Friedman, Daniel. “Equilibrium in Evolutionary Games: Some Experimental Results.” The Economic Journal, Vol. 106, No. 434, January 1996, pp. 1-25.

Friedman, Milton. “Bimetallism Revisited.” The Journal of Economic Perspectives, Vol. 4, No. 4, Fall 1990, pp. 85-104.

Fudenberg Drew and David K. Levine “Measuring Players’ loses in Experimental Games.” The Quarterly Journal of Economics, Vol. 112, May 1997, No. 2, pp. 507-536.

Fudenberg Drew and David K. Levine. “The Theory of Learning in Games.” The MIT Press, Cambridge, Massachusetts, 1996.

Fudenberg, Drew and David K. Levine. “Superstition and Rational Learning.” 2005, Mimeo.

Fudenberg, Drew and David K. Levine. “Self-Confirming Equilibrium.” Econometrica, Vol. 61, May 1993, No. 3, pp. 523-545.

Fudenberg, Drew and David K Levine. “Steady-State Learning and Nash Equilibrium.” Econometrica, Vol. 61, May 1993, No. 3, pp. 547-573.

Fukuyama, Francis. “Social Capital and Development: The Coming Agenda.” SAIS Review, Vol. 22, No. 1, Winter-Spring 2002, pp. 23-37.

Fukuyama, Francis. “Social Capital, Civil Society and Development.” Third World Quarterly, Vol. 22, No. 1, 2001, pp. 7-20.

Golden, Miriam. “Interest Representation, Party Systems and the State: Italy in Comparative Perspective.” Comparative Politics, April 1986, pp. 279-301.

Grossman, Gene and Elhanan Helpman. “Special Interest Politics.” MIT Press, Massachusetts, 2001.

Guth, Werner, Peter Ockenfels and Markus Wendel. “Cooperation Based on Trust: an Experimental Investigation.” Journal of Economic Psychology 18, 1997, pp. 15-43.

Haber, Stephen, Armando Razo, and Noel Maurer. “The Politics of Property Rights, Political Instability, Credible Commitments, and Economic Growth in Mexico, 1876-1929.” Cambridge University Press, Cambridge, UK, 2003.

Hallin, Daniel C. and Stylianos Papathanassopoulos. “Political Clientelism and the Media: Southern Europe and Latin America in Comparative Perspective.” Media, Culture and Society, Vol. 24, 2002, pp. 175-195.

Hargreaves–Heap, Shaun and Yanis Varoufakis. “Some Experimental Evidence on the Evolution of Discrimination, Cooperation and Perceptions of Fairness.” The Economic Journal, Vol. 112, July 2002, pp. 679-703.

Harrison, Glenn and Kevin McCabe. “Expectations and Fairness in a Simple Bargaining Experiment.” International Journal of Game Theory 25, 1996, pp. 303-327.

Hayes, Alexander D . “The Recent Economic History of the United States.” The Quarterly Journal of Economics, Vol. 19, No. 2, February 1905, pp. 167-209.

Iyengar, Shanto and Adam Simon. “New Perspectives and Evidence on Political Communication and Campaign Effects.” Annual Review of Psychology, Vol. 51, February 2000, pp. 149-169.

Jackson, Matthew, and Ehud Kalai. “Social Learning in Recurring Games.” Games and Economic Behavior 21, 1997, pp. 102-134.

Kalai, Ehud, and Ehud Lehrer. “Rational Learning Leads to Nash Equilibrium.” Econometrica, Vol. 61, No. 5, September 1993, pp. 1019-1045.

Kau, James, Donald Keenan, and Paul Rubin. “A General Equilibrium Model of Congressional Voting.” The Quarterly Journal of Economics, Vol. 97, No. 2, May 1982, pp. 271-293.

Kiewiet, Roderick and Douglas Rivers. “A Retrospective on Retrospective Voting.” Political Behavior, Vol. 6, No. 4, 1984, pp. 369-393.

Kramer, Gerard H. “Short-Term Fluctuations in U.S. Voting Behavior, 1896-1964.” The American Political Science Review, Vol. 65, No. 1, March 1971, pp. 131-143.

Kynland, Finn and Edward Prescott. “Rules Rather than Discretion: The Inconsistency of Optimal Plans.” The Journal of Political Economy, Vol. 85, June 1977, pp. 473-492.

Levine, David K. “Modeling Altruism and Spitefulness in Experiments.” Review of Economic Dynamics 1, 1998, pp. 593-622.

Levitt, Stephen. “Policy Watch: Congressional Campaign Finance Reform.” The Journal of Economic Perspectives, Vol. 9, No. 1, Winter 1995, pp. 183-193.

Mailath, George. “Do people Play Nash Equilibrium? Lessons from Evolutionary Game Theory.” Journal of Economic Literature, Vol. 36 No. 3, September 1998, pp. 1347-1374.

Marks, Gary and Norman Miller. “Ten Years of Research on the False-Consensus Effect: An Empirical and Theoretical Review.” Psychological Bulletin, Vol. 102, 1987, pp. 72-90.

McKelvey, Richard and Thomas Palfrey. “An Experimental Study of the Centipede Game.” Econometrica, Vol. 60 No. 4, July 1992, pp. 803-836.

McKelvey, Richard and Thomas Palfrey. "Quantal Response Equilibria for Extensive Form Games." Experimental Economics 1, 1998, pp. 9-41.

Michalos, Alex. "Ethical Considerations Regarding Public Opinion Polling During Election Campaigns." Journal of Business Ethics 10, 1991, pp. 403-422.

Monroe, Kirsten. "Econometric Analyses of Electoral Behavior: A Critical Review." Political Behavior, Vol. 1, No. 2, June 1979, pp. 137-173.

Morwitz, Vicky G. and Carol Pluzinski. "Do Polls Reflect Opinions or Do Opinions Reflect Polls? The Impact of Political Polling on Voters' Expectations, Preferences, and Behavior." Journal of Consumer Research, Vol. 23, June 1996, pp. 53-67.

Murphy, Ryan, Amnon Rappoport and James Parco. "The Breakdown of Cooperation in Iterative Real-Time Trust Dilemmas." Experimental Economics 9, 2006, pp. 147-166.

Nagel, Rosemary and Fang Fang Tang. "Experimental Results on the Centipede Game in Normal Form: An Investigation on Learning." Journal of Mathematical Psychology 42, 1998, pp. 356-384.

Ortmann, Andreas, John Fitzgerald and Carl Boeing. "Trust, Reciprocity and Social History: a Re-examination." Experimental Economics 3, 2000, pp. 81-100.

Oxoby, Robert. "Cognitive Dissonance, Status and Growth of the Underclass." The Economic Journal 114, October 2004, pp. 727-749.

Person, Torsten and Guido Tabellini. "Political Economics: Explaining Economic Policy". MIT Press, Massachusetts, 2000.

Prat, Andrea. “An Economic Analysis of Campaign Finance.” Mimeo, October 1999.

Przeworsky, Adam and Michael Wallerstein. “The Structure of Class Conflict in Democratic Capitalist Societies.” American Political Science Review, Vol. 76, June 1982, pp. 215-238.

Przeworsky, Adam and Michael Wallerstein. “Structural Dependence of the State on Capital.” American Political Science Review, March 1988, Vol. 82, pp. 11-29.

Putnam, Robert. “Bowling Alone: America’s Declining Social Capital”, Journal of Democracy, 6.1, 1995, pp. 65-78.

Rabin, Matthew. “Incorporating Fairness into Game Theory and Economics.” The American Economic Review, December 1993, pp. 1281-1302.

Rappoport, Amnon, William Stein, James Parco and Nicholas Thomas. “Equilibrium Play and Adaptive Learning in a Three-Person Centipede Game.” Games and Economic Behavior 43, 2003, pp. 239-265.

Roberts, John and Keith Legg. “Political Strategies for Economic Manipulation: Democratic Election in Greece, 1960-1985.” The Western Political Quarterly, Vol. 44, No. 1, March 1991, pp. 39-65.

Rockoff, Hugh. “The ‘Wizard of Oz’ as a Monetary Allegory.” The Journal of Political Economy, Vol. 98, No. 4, August 1990, pp.739-760.

Rosenberg, Emily. “Foundations of United States International Financial Power: Gold Standard Diplomacy, 1900-1905.” The Business History Review, Vol. 59, No. 2, Summer 1985, pp 169-202.

Roth, Alvin and Francoise Schoumaker. “Expectations and Reputations in Bargaining: An Experimental Study.” The American Economic Review, Vol. 73, No. 3, June 1983, pp. 362-372.

Sahai, Hardeo and Adwer Khurshid. “On Analysis of Epidemiological Data Involving a 2x2 Contingency Table: An Overview of Fisher’s Exact Test and Yates’ Correction for Continuity.” Journal of Biopharmaceutical Statistics 5 (1), 1995, pp. 43-70.

Schultz, Christian. “Strategic Campaigns and Redistributive Politics”. Mimeo, September 2003.

Sims, Judy Rene. “Pluralism as *Diaploki*: The Interplay of Politicians with Media Owners in Greek Radio Broadcasting.” Journal of Radio Studies, Winter 2003.

Snyder, James and Michael Ting. “Interest Groups and the Electoral Control of Politicians.” Mimeo, February 2005.

Tsakalotos, Euclid. “The Political Economy of Social Democratic Economic Policies: The PASOK Experiment in Greece.” Oxford Review of Economic Policy, 1998, Vol. 14, Number 1, pp. 114-138.

Tsakalotos, Euclid and Antigone Lyberaki. “Reforming the Economy without Society: Social and Institutional Constraints to Economic Reform in post-1974 Greece.” New Political Economy, Vol.7, No. 1, 2002, pp. 93-114.

Voulgaris, Yiannis. “Greece of the-Post Dictatorship Period: 1974-1990: Stable Democracy Marked by the History of this Era.” Themelio Press, Athens, 2002.

Weibull, Jorgen. “Evolutionary Game Theory.” The MIT Press, Cambridge, Massachusetts, 1997.

Winkler, Adam. “Other People's Money: Corporations, Agency Costs, and Campaign Finance Law.” Georgetown Law Journal, June 2004.

Zauner, Klaus G. “A Payoff Uncertainty Explanation of Results in Experimental Centipede Games.” Games and Economic Behavior 26, 1999, pp. 157-185.